EDITION B

The Journal of the INSTITUTION OF PRODUCTION ENGINEERS

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JULY, 1942

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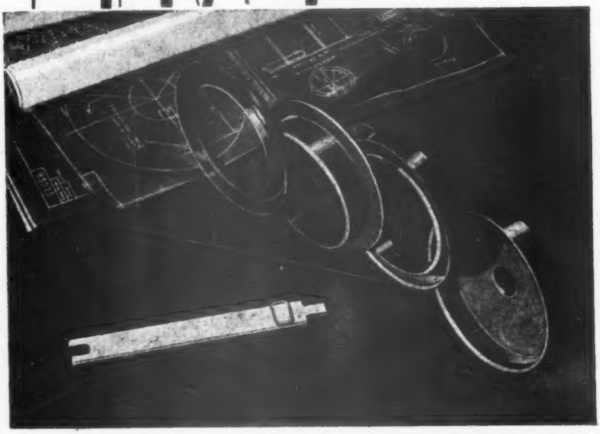

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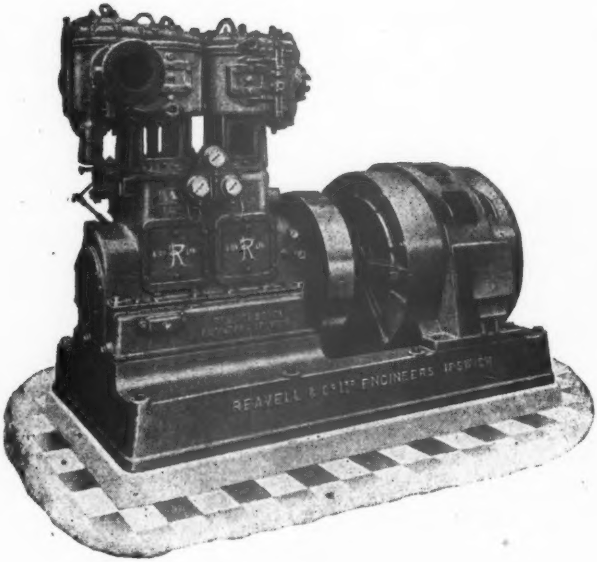

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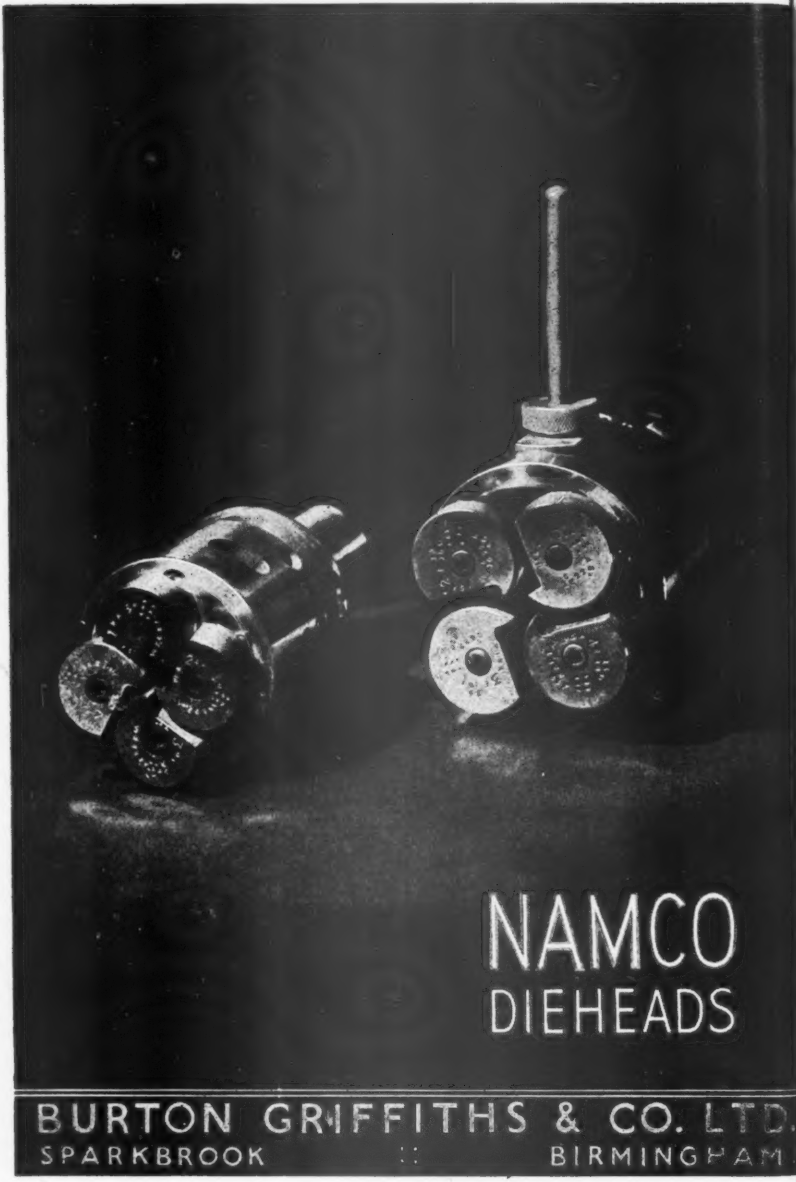
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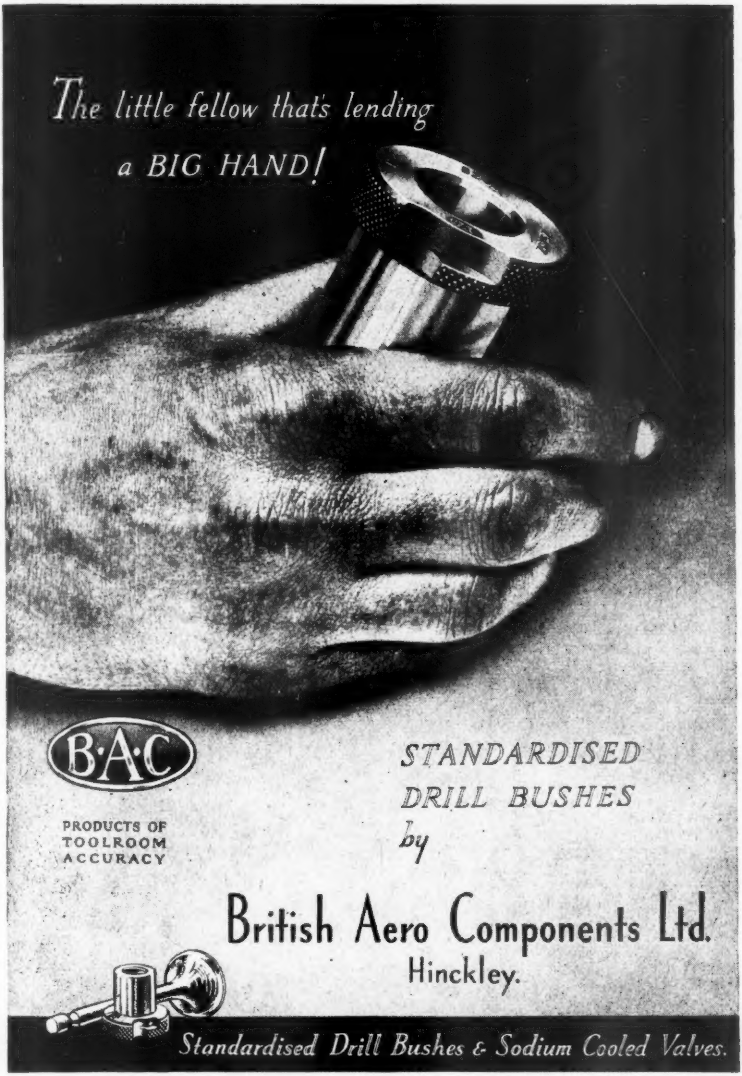
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INDEX TO ADVERTISEMENTS

As a war-time measure the advertisement section of this Journal is now published in two editions, A and B. Advertisers' announcements only appear in one edition each month, advertisements in edition A alternating with those in edition B the following month. This Index gives the page number and edition in which the advertisements appear for the current month.

The fact that goods made of raw materials in short supply owing to war conditions are advertised in "The Journal" should not be taken as an indication that they are necessarily available for export.

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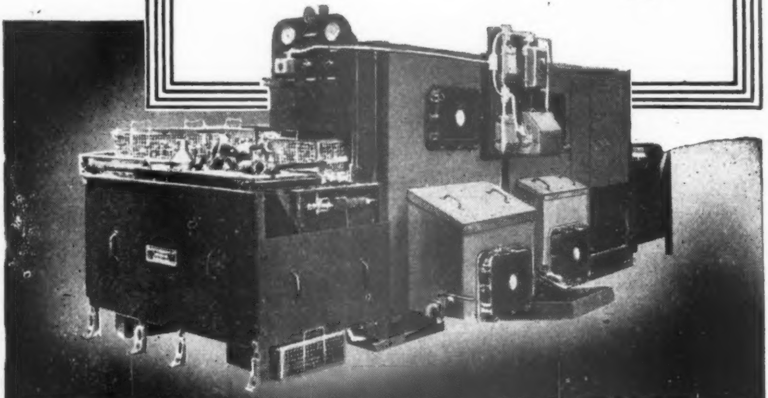

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INSTITUTION NOTES

July, 1942

Mr. J. F. Gibbons Appointed Assistant Secretary (Technical)

JAMES F. GIBBONS
A.M.I.P.E.

Mr. James F. Gibbons, A.M.I.P.E., A.M.I.Mech.E., A.M.I.Mar.E., has been appointed Assistant Secretary (Technical) to the Institution. Mr. Gibbons, who is 36 years of age, was lately on the staff of Crossley-Premier Engines, Ltd. Educated at Trent College and Nottingham University, his technical education was received at the Manchester College of Technology and Rugby Technical School.

Dr. Schlesinger Elected an Hon. Member.

The Council of the Institution at its meeting on June 19 elected Dr. Geo. Schlesinger, Director of our Research Department, an Honorary Member of the Institution. The American Society of Mechanical Engineers conferred a similar honour on him some time ago.

Membership Now Over 3,000.

At the close of the Institution's financial year, June 30, Institution membership was 3,030, compared with 2,587 at the end of June, 1941

Obituary.

We regret to learn of the deaths of Mr. B. J. Hugo (*Member*), Coventry Section ; Mr. G. W. Marner (*Member*), Sydney Section ; Mr. H. G. Povey (*Member*), Birmingham Section ; and Mr. R. F. Rogers (*Graduate*), London Section. Mr. Hugo attended the first meeting held in London in 1921 to start the Institution. Mr. Povey, an active member since 1928, was the author of two papers given to the Institution and contributed to the discussions at many meetings.

Subscriptions of Members Serving in H.M. Forces.

The Council has decided that members serving in H.M. Forces who wish to continue receiving the publications of the Institution,

are to be called on to pay only half their usual subscription rates, and that, where the publications are not required, payment of subscriptions will be temporarily discontinued.

South Wales and Monmouthshire Section.

The Council has authorised the establishment of a new Local Section to be known as the South Wales and Monmouthshire Section. Steps are being taken to set up a Provisional Committee to make the necessary arrangements.

Next Chairman of Council.

The next Chairman of Council, in succession to Mr. N. V. Kipping, who retires from that office at the Annual Meeting later this year, is to be Mr. H. A. Hartley, Chairman of the Standards Committee of the Institution and formerly President of the Eastern Counties Section.

Annual Election to Council—Official Notice.

NOTICE IS HEREBY GIVEN of an election to fill seven vacancies amongst the Ordinary Members of Council. The names of the retiring Ordinary Members of Council who are willing to stand for re-election are here set out, together with a note of their attendances at Council Meetings since their last election :

Mr. W. F. DORMER (attendances, 6 out of 8).

Mr. JAMES FRANCE (co-opted since last election ; attendances, 2 out of 2).

Mr. E. J. H. JONES (attendances, 4 out of 8).

MR. F. WILLIAMS (attendances, 3 out of 8).

Candidates for election (who must be Honorary Members or Ordinary Members) must be nominated in writing by three Ordinary Members or Associate Members, except that retiring Councillors willing to stand for re-election do not require nomination. Each Selection Committee may nominate one candidate.

In the event of a ballot being required, a ballot paper will be forwarded to all Ordinary Members, Associate Members and Intermediate Associate Members with a registered address within the United Kingdom.

Nominations should be forwarded to me at the offices of the Institution, 36, Portman Square, London, W.1. The latest time for receiving nominations is the last post on Monday, August 17, 1942.

R. HAZLETON,
General Secretary.

July 20, 1942.

The Council of the Institution, 1940-41

PRESIDENT: G. E. BAILEY.

DEPUTY-PRESIDENT: The Right Hon. LORD SEMPILL, A.F.C.

CHAIRMAN OF COUNCIL: N. V. KIPPING.

VICE-PRESIDENTS (Presidents of Local Sections): Major T. M. Barlow, *Manchester*; J. Blackshaw, *London*; J. A. Boyes, *Coventry*; R. Broomhead, *Luton*; D. R. Burns, *Edinburgh*; C. G. Crane, *Sydney*; R. C. Fenton, *Birmingham*; I. Garvie, *Glasgow*; H. J. Gibbons, *Nottingham*; J. R. Gimson, *Leicester*; J. T. Kenworthy, *Western*; F. G. Laws, *Eastern*; H. B. Pratt, *Southern*; R. D. G. Ryder, *Preston*; A. Sykes, *Yorkshire*; J. W. Walker, *Sheffield*; J. G. Young, *Cornwall*.

PAST-PRESIDENTS: Lord Austin, K.B.E., Sir A. Herbert, K.B.E., Viscount Nuffield, O.B.E., J. D. Scaife.

PAST-VICE-PRESIDENTS: J. H. Bingham, H. A. Drane, B. C. Jenkins, R. H. Youngash.

ADDITIONAL SECTION REPRESENTATIVES: E. P. Edwards, *Birmingham*; H. le Cheminant, G. H. Hales, and F. W. Halliwell, *London*; J. Davies, *Manchester*.

ORDINARY MEMBERS: J. W. Berry, H. D. S. Burgess, W. F. Dormer, T. Fraser, E. W. Hancock, J. A. Hannay, H. A. Hartley, E. J. H. Jones, W. Puckey, F. A. Pucknell, H. Scholfield, M.B.E., Ph.D., J. R. Sinclair, F. Williams, I. H. Wright.

GENERAL SECRETARY: Richard Hazleton.

DIRECTOR OF RESEARCH: Dr. Geo. Schlesinger.

ASSISTANT GENERAL SECRETARY: W. Stancliffe Marsden.

ASSISTANT DIRECTOR OF RESEARCH: D. F. Galloway, B.Sc.

Section Hon. Secretaries:

Birmingham: F. C. White, "Birkmyre," Signal Hayes Road, Walmley, Birmingham 24.

Cornwall: J. Arthur, "Clifton," Mount Pleasant Road, Camborne, Cornwall.

Coventry: A. W. Buckland, 3, Cawston Way, Bilton, Rugby.

Eastern Counties: D. Braid, 263, Cauldwell Hall Road, Ipswich.

Edinburgh: P. H. Lee, The North British Rubber Company, Castle Mills, Edinburgh 3.

Glasgow: W. Crawford Miller, "Delmore," Bishopton, Renfrewshire.

Leicester and District: H. S. Burdett, 18, Stanfell Road, Leicester.

London: R. Hazleton, 36, Portman Square, London, W.1.

Luton, Bedford, and District: H. J. W. Smith, 20, Highfield Rd., Luton, Beds.

Manchester: F. W. Cranmer, Associated British Machine Tool Makers, Ltd., Lloyds Bank Buildings, King Street, Manchester 2.

Nottingham: L. Shenton, "The Anchorage," Shaftsbury Avenue, Sandiacre, Notts.

Preston: R. G. Ryder, Thomas Ryder & Sons, Ltd., Turner Bridge Works, Bolton, Lancs.

Sheffield and District: J. Clare, St. James' Chambers, 38, Church Street, Sheffield 1.

Southern: H. B. Pratt (Section President), Vickers Armstrong, Ltd., Supermarine Works, Southampton.

Sydney, N.S.W.: J. M. Steer, Associated Machine Tools Australia Pty. Ltd., 260-262, Kent Street, Sydney, Australia.

Western: H. D. Glover, 63, Trelawney Road, Bristol 6.

Yorkshire: W. Hirst, 31, Warneford Rise, Cowlersley, Huddersfield.

Birmingham Graduate: R. T. Sillitoe, 181, West Heath Road, Northfield Birmingham 31.

Coventry Graduate: A. E. Riley, 297, Green Lane, Coventry.

London Graduate: E. G. Nunn, "Heimat," Little Bushey Lane, Bushey, Herts.

Loughborough College Student Centre: T. E. N. Fargher, Ph.D., M.Eng.

THE INSTITUTION OF PRODUCTION ENGINEERS

36, Portman Square, London, W.1

PUBLICATIONS OF THE RESEARCH DEPARTMENT

February, 1942

REPORT ON SURFACE FINISH, price 15/7 post free*

Part II. ACCEPTANCE TEST CHARTS FOR MACHINE TOOLS, price 5/7 post free

Earlier Publications

ACCURACY IN MACHINE TOOLS: How to measure and maintain it, price 3/3 post free

Part I. ACCEPTANCE TEST CHARTS FOR MACHINE TOOLS, price 5/6 post free

Also the following reports which appeared in the Institution's *Journal*, copies 5/- each, post free

	Vol. No.		
Cutting Tools	XVIII, 11	1939	February
Dial Gauge and Its Use	XVIII, 11	1939	November
Research on Surface Finish (Preliminary Report)	XIX, 3	1940	March
Substitute Materials	XIX, 7	1940	August
Modern Measuring Instruments and the Principles of their Design	XIX, 9	1940	September
The Rebuilding of Old Machine Tools for the Requirements of War	XIX, 10	1940	October
The Effect of Reversing Flat Leather Belts	XX, 5	1941	May
The Natural Sag of Test Mandrels and its Consideration in Checking Machine Tools	XX, 1	1941	January
The Influence of Warming-up on Capstan and Combination Turret Lathes ..	XX, 4	1941	April
Taps, Efficiency, and Correct Design ..	XX, 6	1941	June

*Price to Members only, 10/7

INAUGURAL MEETING OF THE NORTHERN IRELAND SECTION

THE Inaugural Meering of the Northern Ireland Section of the Institution was held in the Great Hall of Queen's University, Belfast, on Thursday, April 9, 1942, Mr. Alexander Brown, Chairman of the Provisional Committee, in the Chair. The attendance numbered over three hundred members and visitors. The Council of the Institution was represented by Lord Sempill, Deputy-President. Messages conveying good wishes and greetings were received from the President, the Chairman of Council, and the Committees of all Local Sections in Great Britain.

The following elections were carried out: Section President, Mr. Alexander Brown. Section Hon. Secretary, Mr. D. H. Alexander, M.Sc., Sen.Wh.Sch. (Principal, Belfast College of Technology). Other members of Committee, Messrs. W. Browning, C. C. Bowman, E. Cuthbert, S. O. Hicks, A. F. Shillington, and W. M. Trotter.

Mr. Alexander Brown, Section President.

MR. ALEXANDER BROWN, Chairman, said: You all know the purpose for which we have gathered here to-night. When the first informal meeting was held in Belfast the audience consisted of some severe critics, with myself probably their leader. Why was it necessary to have another Engineering Institution? Why did not this new group tack themselves on to some of the existing Engineering Institutions? What interest had the North of Ireland in production engineering, when one bears in mind that in the accepted sense there was no mass production in the North of Ireland? Take our engineering shops in Belfast and the provinces. They are in essence jobbing shops engaged in general engineering, from shipbuilding downwards. Round the table at this first meeting we could not see that the Institution of Production Engineers was going to be of very much interest to us, and the meeting more or less closed upon that note.

Then a very clever thing happened. The Institution of Production Engineers sent out samples of its literature to those who had attended that meeting, and so far as I am concerned I became an immediate convert. I may say that no Engineering Institution of my knowledge issues more helpful literature than The Institution of Production Engineers. It is a type of literature which will be of assistance to every engineering enterprise, independent of the class of work they are engaged in.

This Institution was founded in 1921 and was established with one prime purpose in view :—To promote the science and practice of production engineering. Its membership to-day is about 3,000. My study of its aims and methods may be divided into three parts : (1) The past, (2) The Present (war conditions) and (3) The Future.

The Past. They have set up a Research Department to consider production methods, Standardization, Machine Tools, Surface Finish, Cutting Tools, Cutting Compounds, Screw Threads—just to mention a few of the items they have taken up, and anyone who has had the opportunity of reading their literature on any of these subjects cannot but be struck with its excellence and the good quality of the work done.

The Present (*war conditions*). The total dedication of the Institution to the task of helping to win the war. Meetings, papers, and discussions on munitions production. The skilled use of available labour. Training of unskilled workers. Development and use of substitute materials ; and, what strikes me as most important of all, the alteration of old and obsolete designs to bring them into line with modern practice. Anyone who has had experience of going to some of our Government Departments and tried to get them to alter designs, will know the difficult job it is to bring them into line with modern methods of production.

The Future. To put the British manufacturers in a position by the use of scientific production methods to get a fair share of the world's markets after the war.

Now, why establish Local Centres as we are proposing to do to-night ? It is because of the many national tasks upon which the Institution is engaged and a desire to obtain the fullest co-operation from the whole of the country.

I have very little more to say in introducing this subject, but it is my special privilege to give a welcome to the distinguished gentlemen we have upon our platform to-night. Out of ordinary courtesy we must make reference to our cross-channel visitors, first of all. I had the opportunity of meeting for the first time Lord Sempill last night—he is sitting on my immediate right (Applause). I can assure you from several hours' talk I had with him that he is no guinea-pig Director nor a mere figurehead—he represents the Council to-night and has been a moving spirit of the Institution for many years. He was preceded as its President by the late Lord Austin, and succeeded by Lord Nuffield, so you will see he was in very good company. But the thing that should make more appeal to us to-night is that he is a practical engineer having served his time at the bench and later on turning his activities to the development of flying on the technical and practical side for over thirty years. His associations with Belfast are not new, for he has been here before. He was the first man to visualise

the use of reclaimed land as an aerodrome at our present Municipal Airport, and was very largely responsible for founding the Belfast Light Aeroplane Club, making the first and only circuit of Britain and Ireland in the Light Seaplane race of about 16 years ago. I am sure, gentleman, you will give Lord Sempill a hearty welcome among us and you will be charmed with him when his turn to speak comes along.

I also wish to refer to Mr. Hazleton, the General Secretary of the Institution. The best thing I can say about him is that his father was an Ulsterman who came from Dungannon, and perhaps the worst thing, from the engineering point of view, is that he was an M.P. for over 12 years representing North Galway ! He could tell you quite a lot of interesting things about Irish history and politics but I have made it clear to him that such subjects are taboo to-night ! He has travelled extensively on lecture tours in the U.S.A., Australia, New Zealand, etc., and he was a member of the Prime Minister's Reconstruction Committee in 1917.

We also have with us Lieut. Marsden, Assistant Secretary, who has been sent to Ulster for military purposes, and it was a good thing he was here, because it was through him that the first meeting was held and I know from personal experience that he has put a lot of very hard work in since.

Then among our local gentlemen we have the Rt. Hon. Sir Basil Brooke, Minister of Production, and it is in this capacity we welcome him here to-night. I think, Sir Basil, I can assure you that in your difficult task you have the sympathy of every thinking engineer in this meeting. They know the difficulties you are up against ; they know the hard work you have to do and we wish you every success in your task. The Vice-Chancellor of Queen's University is also with us ; we are, as it were his tenants, and we are greatly obliged to him for giving us facilities to hold our meeting in this hall. Lastly, we have the Rt. Hon. H. G. H. Mulholland, Speaker of the House of Commons. We don't want him here as the official Speaker but welcome him for his own great personality. He has come here to-night with great diffidence, claiming that he knows little about engineering. He is always very modest outside his own profession, in which he has great ability, and with the machinery at his disposal he has made no mean contribution to the war effort. (Applause).

Sir Basil Brooke, Minister of Production.

THE RIGHT HON. SIR BASIL BROOKE, M.P., Minister of Commerce and Production, said : Your Institution reaches its majority this year and I can think of no better celebration of that occasion than that a branch—the 23rd, I believe—should be established in Northern Ireland.

Looking at your Constitution I see that your object is: "to promote the science and practice of production engineering." Such an object is of value and importance to the community at any time and at this time it is vital. Your activities seem to me to fall into what I might describe as tactical and strategical categories. Your tactical or short term planning provides for consultations with Government Departments when they are in need of expert advice—I hope that later on Lord Sempill is going to tell us about that in detail. You issue a *Technical Bulletin* on urgent technical problems, arrange lectures and discussions, and have set up specialized Committees, notably the War Emergency Committee in London. Your long term policy is taken care of, as our American friends here say, by your Research Department, some of whose valuable work may be seen in the pamphlets available to-night on such subjects as "Acceptance Test Charts for Machine Tools" and "Surface Finish,"

Even at a superficial glance the value of your Institution to a nation at war cannot be disputed, and I welcome cordially the establishment of a Northern Ireland Section. I feel that we, who are immediately concerned with production, may look back to this day as marking an important stage in the struggle that is being waged by Northern Ireland on the production front.

Let me touch briefly on that struggle for which, as Minister of Production, I am responsible. This responsibility was not always mine. In the early days of the war the part of my Ministry was chiefly to assist Imperial Supply Departments directly responsible to London to obtain their requirements from this area and to transfer industrial capacity from civil to war work. But since June last I have been directly responsible for general production questions. We in Northern Ireland have had to pay, in common with England, for our peace-time indifference to the problems of the engineering industry. We are still suffering from that pre-war hangover, I might almost call it. There is no need for me to tell you of the decay in the system of trade apprenticeship in the engineering trade and the consequent decline in the number of skilled men available. You know better than I do the tremendous work involved in switching industries from a peacetime to a wartime basis. You have experienced the inevitable and unprecedented demands for machinery, tools and equipment. These problems are all being met and tackled here.

We had a large reserve of labour to draw upon, and we have now reduced our labour reserve from 60,000 to 20,000. We secured agreement on dilution and we are using increasingly semi-skilled and unskilled men and women in our war factories. We have recognised that merely to set men and women to work is not enough, they must be given the work for which they are best suited and

needed. To achieve this economy and efficiency in the use of labour the Ministry of Labour, Northern Ireland, have now set up a labour supply inspectorate and it is my earnest hope that this will lead to the best possible use of our man and woman power. The process of changing over to a wartime basis inevitably means the decline, and sometimes the cessation, of what were purely peacetime industries. The labour released in this way must be utilised, and, accordingly, I have made every effort, and with a fair measure of success, to have new works established in Ulster which will absorb these workers.

Even in factories that are already producing a wartime requirement, the change-over calls for the utmost measure of co-operation on the part of employer and employee. Inevitably misunderstandings and grievances are a by-product of the change and because I feel that these should be ventilated and not pushed underground I established a Production Advisory Committee, of which I am Chairman, where employers, trade union leaders, and Government officials can hammer out their problems. I am also in process of setting up Works Committees in our principal factories, following the recent agreement in London, where managers and workers can discuss problems on the spot, both personal and official, and arrive at a new understanding of one another's difficulties, and we hope a solution of their problems.

Here I should like to mention a particularly pressing problem that has recently come before these Committees—the need to go all out on day and night work on our machine tools. At present these tools are being operated two shifts of 8 each hours and we want them operating for 24 hours out of the 24. If we get this we can increase our machine tool output by 50 per cent. If we do not get it we lose that increased percentage and a chance of getting more tools, for the authorities will not give us more machine tools unless we use our existing ones to the utmost. I know that night-shifts are inconvenient and uncomfortable affairs. But I know also the men of Northern Ireland and they are not looking for a comfortable war any more than their friends and brothers elsewhere. I feel sure that their response to this appeal will be immediate and wholehearted.

There are, of course, bottlenecks. Some people talk as if their existence were abnormal and inexcusable. One of my many critics said recently that he had never heard of bottlenecks before this war. Of course he hadn't. The pre-war conditions governing the supply of materials, transport and urgency of work were such that the bottlenecks, if they existed, never became obvious. It is clear that a most delicate perfection of synchronisation is necessary to ensure that a factory shall have the material, the tools and the

labour all together. War has a way of being incalculable. In the course of one day a source of supply may be cut off, in an hour transport may be dislocated, and overnight, as we in this city know, the work and the hopes of months may be smashed from the skies. Believe me, I don't like bottlenecks. It is an ugly word and an ugly exasperating thing, but bottlenecks can be and are being overcome. And the critics say there are mistakes. Of course there are. Take a plane that requires 120,000 parts and over half a million operations. Think of the task of jigging and tooling it for mass production. To do that without a single mistake would be a minor miracle.

But I forget I am preaching to the converted. Briefly, all that I am trying to say is that in Northern Ireland in every way we know we are out for more production — by eliminating bottlenecks, by providing means for discussion between employers and employees and between trade unions, managements, and the Government; by providing for the welfare of the workers by establishing canteens and other facilities; by absorbing workers from the dying industries into new war work and by the intelligent and maximum use of labour. Let me say one last general word. This is a war in which courage is not enough. I think it has been proved that man for man our enemies have not the fighting spirit and endurance of our troops, yet almost everywhere, with the notable exception of Russia, they are a conquering force. Why? Because they are magnificently equipped. Not only were their factories on a war-production basis when this war started, they had been producing the instruments of war for years before. And now not only the people of Germany but the conquered nations of Europe are being used to turn out more and more weapons with which to strike the next blow.

The daring of the enemy is the false courage of the gangster with the gun in his hand. Our position at the moment might be likened to that of the G man who has taken the measure of the crime and identified the criminal, but who must wait for the weapon that will destroy him. We must give our men and our allies the weapons they need. We have no right to ask them to fight these modern monsters unless we give them the weapons to do it, and we can give them those weapons. We re-equipped an army after Dunkirk. We fitted out an army in the Middle East. We are now supplying Russia and must continue to supply her. And we must build up a reserve not only to meet the next blow wherever it may fall, but against the day when, superior in equipment as well as in spirit, we can take the initiative.

I see your Institution as the essence of co-operation—a new science at the service both of engineering industries and Government Departments alike, in helping to find practical solutions for the endless problems thrown up by wartime conditions. It is that

spirit of co-operation that I chiefly welcome. The Nazis have a slogan—and a slogan which so far they have translated into practical success—" Divide to destroy." That is a negative creed. I would oppose it with a positive one—" Co-operate to conquer." I believe that this is the spirit that lies behind the achievements and the work of your Institution. It is the spirit which I am certain will ultimately give us victory. (Applause).

Lord Sempill, Deputy-President.

THE RIGHT HON. LORD SEMIPLL, A.F.C., Deputy-President of the Institution, said : Mr. Chairman, Sir Basil Brooke, Mr. Speaker, and Gentlemen.—It is an honour and a pleasure for me to be here this evening to represent the Institution of Production Engineers and to bring you the congratulations and good wishes of its President and Council.

War is a hideous thing, but, western civilisation and western science being what they are, we have to recognise that in addition to bringing out the best and the worst in human nature the stern necessity of war rapidly brings about inventions and developments that otherwise would take a long time to achieve.

It was due almost entirely to the problems of production experienced in the last war that this Institution had its origin twenty-one years ago. Perhaps it is not in spite of the present war but largely because of it that we have met here this evening to inaugurate a Northern Ireland Section of the Institution. If necessity is the Mother of invention, the Father of the Institution of Production Engineers bears the same name. There have been for years a great many professional and scientific engineering institutions doing splendid work in their various fields, based for the most part on the needs of particular industries such as the constructional industries, the mechanical, electrical, aeronautical, automobile industries, and so on. There being no such thing as an industry of production engineering, the science of production engineering was neglected and the needs of those directly concerned with production were not adequately catered for by the older engineering institutions. The last war and the growth of quantity production compelled those men to set up an institution of their own. They set up this Institution as a scientific body with one object only as mentioned by Sir Basil Brooke—" To promote the science and practice of production engineering."

Now, what is this science of production engineering? Our General Secretary once defined it somewhat facetiously as that science which will enable us to make more and more for less and less and will end by enabling us to make everything for nothing ! That is perhaps over-optimistic from the point of view of the cost office and the customer, and need not be taken too tragically by harassed

directors concerned with the balance sheet, but it conveys a rough idea of what it is all about, subject to the qualification that this science can be of service in the building of a ship as well as in the making of millions of such things as motor cars or radio sets. In relation to manufacture it is the science of the five M's—men, machines, materials, methods and management.

The education, training and proper utilisation of personnel in our engineering factories, from the humble apprentice or trainee up to the chief production engineer and the works and general manager, is a prime concern of our science and on certain aspects of this I will have more to say later.

Machine tools and their accessories form, of course, the chief equipment for engineering manufacture. The production engineer is concerned not with their design but with their utilisation. Through the generosity of my successor in the office of President of the Institution, Lord Nuffield, we were enabled to start a Research Department in charge of which we have as Director, Dr. Schlesinger, a man who is recognised throughout the world as one of the greatest living authorities on the design and utilisation of machine tools.

We generally think of engineering materials in terms of metals, but plastics and other materials are coming into wider use and the production engineer must keep abreast of the latest developments in this direction as well as abreast of all that concerns the working of metals.

It cannot be too strongly emphasised that the core of our science, first, last and all the time, is methods of manufacture. That is why the entire range of the engineering industries is concerned with this science. The best method, usually the shortest and most economical method of doing this, that and the other—that is what it is all about. It used to be held that design was no concern of the production engineer, whose job was to make just what he was told to make. Not so to-day. Our Institution during this time of war has had to stress again and again the need of designing to facilitate production. Simple changes of design often result not only in the time of manufacture being enormously reduced, thus saving thousands of man hours on a job, but in great saving of precious material often in short supply. Instead of machining certain components from solid metal, for instance, a modification of design may enable them to be fabricated from tubing without any loss of strength or operational efficiency. Again, we found in Britain that one of the greatest single factors hampering war production was bad methods of ordering. The Institution has had a considerable influence in improving matters in that direction, though much still remains to be done.

The late Lord Austin, one time President, who served on our

Council for ten years up to his death nine or ten months ago used to say that a production engineer had to be 50% an engineer and 50% a manager. Lord Nuffield has taken a similar view, declaring that we have plenty of good engineers but not nearly enough men who are both good engineers and good managers. To a much greater extent, therefore, than other engineering institutions ours has to take account of factors such as scientific management, motion and time study, production control and related subjects. It is indeed a wide field. Within our Institution we have set up a series of Committees and Sub-Committees dealing with various aspects of production control, in addition to others covering technical problems such as welding, die casting, and so on.

My aim so far has been to give you a brief picture of the purpose of our Institution. I will not spend much time in describing its functioning. *It is not a London institution*, but a National one, spreading over the Empire, with a senior and a junior section in London, where its headquarters are located, seventeen sections elsewhere in England, two in Scotland, one in Australia, and one in prospect in Canada, and now this new Northern Ireland Section. Membership is approximately three thousand. The Sections hold meetings for lectures and discussions. Every month a *Journal* and a *Technical Bulletin* are published and there are also periodical reports issued by our Research Department, which is doing valuable work in many directions, including work for various Ministries. There are several grades of membership beginning with the student grade, but I will refer only to two. One is that for Associates, into which persons of experience on the production control side are admitted, and the Affiliate grade, consisting of persons nominated by firms affiliated to the Institution. Besides other grants, the Institution hands over to its Research Department *eighty per cent of all subscriptions* received from this Affiliate Membership grade ; in fact, over 16% of its total revenue is given to research. It expects in the coming twelve months to provide an income of about ten thousand pounds for research, of which it will give close on two thousand out of its own funds, looking to industry and official sources for the balance.

In our view two most important fields of activity for the Institution are education and research in production engineering. Germany and the United States have devoted much more attention to both than we have and this neglect has been a most serious handicap. We are too slow in accepting new ideas. It took our Institution years of hard struggle to convince the Board of Education for England and Wales that there ought to be a Higher National Certificate in Production Engineering and we are still in process of trying to convince the Department of Scientific and Industrial Research that our Research Department should receive recogni-

tion and support on lines similar to those given to normal Research Associations. It is sad that so much time and energy should have to be devoted to persuading some official circles to act in matters such as these.

So far as production engineering education in Northern Ireland is concerned, you can, I think, rest assured that your needs here will be fully considered, seeing that Mr. Alexander, Principal of the Belfast College of Technology, has been one of the moving spirits in starting this new Section of which he has been elected Honorary Secretary to-night. In England, Wales and Scotland we have still a long way to go in transforming technical education so that it can cater for the practical production side of engineering. The new Higher National Certificate Courses in Production Engineering under the scheme adopted last year will help greatly in doing that. It was in 1937 that Lord Nuffield and I waited on the President of the Board of Education in London to press for that much-needed reform. We presented him with a memorandum from the Institution pointing out "that the growing importance of the manufacturing side of industry necessitates an entirely different type of technical and specialised education from that provided by the present National Certificate Courses in Mechanical Engineering—one in which the emphasis will be on the science of production rather than on the science of design." Our Institution has been instrumental in getting several technical colleges to start production courses and the new certificate scheme has already been widely welcomed. Mr. Alexander is well aware of all we have done in this connection.

Now I come to a question which I am sure will be uppermost in your minds in connection with the formation of this Northern Ireland Section of the Institution.—How can it be of service to you and to the war effort you are making? It must be built on a solid foundation and inspired and actively supported by the leaders of the engineering world of which our Chairman, Mr. Brown, is one.

When war came and we in Britain set up the War Emergency Committee of the Institution, of which I was for a time the Chairman, we faced a similar question ourselves. The first thing we did was to communicate with our members and ask them what were their chief production difficulties. The response was extensive. The views expressed lacked nothing in strength or clarity. There was a flood of complaints, very largely centering round labour difficulties and the alleged weaknesses of Government departments. We at once came to two decisions. The first was that hours and conditions of labour were questions outside the scope of the Institution, but that the use to be made of labour was a technical matter with which it could properly concern itself. The Committee prepared a memorandum on that subject and the British Minister of Labour, Mr. Bevin, referring to that document, said in a public speech : " I welcome the

Memorandum produced by your Institution on the Recruitment and Training of Labour for War Work; I regard it as extremely helpful and useful, and we have made good use of it . . . . . . We have been very happy to have your War Emergency Committe in association with the officials of the Production and other Departments of the State, and we are grateful to your organisation for the services that have been rendered up to date."

Our second decision was that we would not allow the Institution to be used as a channel for complaints against Government Departments. We would have had a busy time if we had decided otherwise, but while we agreed to examine complaints we decided to limit ourselves to putting forward constructive suggestions only. In pursuance of that policy we have presented to the Government a series of memoranda on production problems, which we have reason to think have produced at least some results.

The latest of these memoranda is one adopted by our Council at its meeting on March 20. It has been presented to the British Minister of Production, Mr. Lyttleton. This will later be published in our *Journal*, but I have obtained permission to present a copy to your Minister of Commerce and Production, Sir Basil Brooke, who is with us to-night, and I now have pleasure in handing this over to him. (Applause.)

With the entry of the United States into the war and the Russian need for machine tools, the Institution considered that our new focus of effort in home production must be to increase output without increased plant facilities. It seemed to us that there are, broadly speaking, only four ways in which this can be done, first, by increased machine activity; second, by simplification of design; third, by rationalisation; and, fourth, by improved manufacturing methods. The memorandum outlines the views of the Council of the Institution under these four heads. We hope it will be of service. We cannot now add to our resources either in man power or machinery, but we can and must make better use of both to produce more.

Here in Northern Ireland I think you should use this Section of the Institution on much the same lines as we have done in Great Britain. It will afford an effective means of bringing you as production engineers together to discuss your difficulties and to concert means of overcoming them. It will place at your disposal the technical knowledge and experience of members in Britain on all sorts of questions, for at our London headquarters committees meet regularly every week to consider members' problems and give advice regarding them. I invite you to submit your problems individually or collectively to those committees. Some of the ablest of our production engineers who are works managers or general

managers of great concerns in the London area find time to do this work because they have assessed its value and find it well worth while as a means of furthering the National war effort. We have also developed a high degree of co-operation amongst our members generally. They go to each others' works, they are available for consultation and advice, their policy is to help all they can.

We know by experience that in this matter of co-operation, particularly with Government Departments, the main difficulty is to get down to brass tacks, to be sufficiently definite and concrete. Generalisations are almost useless. Before anyone can help another he must know on what his help is actually needed. Therefore, I suggest that you schedule and analyse your difficulties under the five M's—men, machines, materials, methods and management. Let us know what they are, and tell us about any ways you may yourselves discover of overcoming problems in which we may also be interested.

Not being familiar with the production position here, I cannot venture to express an opinion as to what is the best immediate use you can make of this new Section you are starting to-night. That you can make it serve your needs I am confident, particularly if you bear in mind that it is not an isolated unit meant to work entirely on its own but part of a much larger body of trained men whose knowledge and experience are freely at your service.

Neither am I venturing to-night to speak of the contribution which you in Northern Ireland are making to the cause of war production. I am glad to believe, from such information as I have, that it is a most valuable and considerable contribution. I look forward while here to seeing and learning much more about it than I yet know and to be able to tell the production engineers of Britain on my return there that your part in the battle of production is one of which you have every reason to be proud. I have to-day seen with great interest and pleasure the works of Messrs. Mackie and Short and Harland.

On our side of the Irish Sea we, too, are proud of what has been achieved in production—proud, but far from complacent or satisfied. We in the Institution hear much about the failures, mistakes, disappointments and inevitable changes of programme and policy that prevent production from reaching that measure of efficiency we all want it to attain. Be sure that the enemy also has his production failures and disappointments about which we hear little or nothing. Our task is to carry on the work to the utmost of our strength and to realise that there is no such thing as finality about how much we can produce. There is always more and more that we can do—that we *must* do—if this war is to be won.

Efficiency is a much overworked term but there comes a time when only greater efficiency can provide the key to greater production. Take two firms of equal size with the same equipment, the same number of skilled operatives making the same product. The output of one will almost certainly be greater than the other. Why? Most often the answer will be better methods, better management. In the last analysis that comes down not to machine-power or even to man-power but to the directing power of mind and character—to the age-old qualities of integrity, leadership, knowledge, judgement, experience and constancy to purpose. Without these qualities our special science or any other science can avail us little. With them we may hope to become, not indeed supermen but perhaps the next best thing, good production engineers.

These truths were clearly recognised at a period in the last war when the position of the Allied cause was in danger in France, and all the Forces in the field were placed under the leadership of that great soldier, the late Marshal Foch. He inspired all with a dynamic purpose and was more responsible than any single individual for the success achieved. He well understood the overwhelming importance of Production, and one of his most significant pronouncements was: "Material is the primary condition of the efficiency of the combatants however excellent they may be. Its quality, nature and composition are the bases upon which the organisation of an army must rest in order to attain victory." We should remember these words and production engineers in particular will, I am sure, give force to their realisation. (Applause).

The Speaker of the House of Commons

Lt.-Col. The Rt. Hon. H. G. H. Mulholland, D.L., M.P., Speaker of the House of Commons, said: I have not yet altogether understood why I am here this evening, because Mr. Brown said, quite wrongly, I was modest. I am not a bit modest about things I know something about, but I have to confess, and the confession is quite an easy one, because I have many friends here to-night who know only too well, that I know nothing whatever about engineering.

In 1921 we had an election. Now you must not be frightened that I am going to talk politics; in the first place I am not a politician and in the second place this is not the time to talk politics, but we had proportional representation and that meant that we had six candidates for the same constituency, and at practically all the meetings which were held throughout the election the whole six of us had to go round and make our six speeches. At that time I was the youngest of the six and therefore I was always the number six speaker on the list. You can imagine that by the time the audience had listened to five speakers that they were not only bored

but that they were also very tired. Now to-night, Gentlemen, having listened to Sir Basil Brooke and Lord Sempill nobody can say that we are bored. I think I have seldom, if ever, listened to two more interesting addresses in one evening, but we may be tired because most of us probably have done a fairly good day's work already and I learnt at that election that when you come well down on the list of speakers, even if the speeches have been good before you rose to your feet, that the wise thing to do was to be very short.

Now my war problem is a very easy one: I want machine tools and cannot get them. I have been chasing Mr. Guthrie and his assistants for machine tools for nearly two years and after what Lord Sempill said to-night I realise that I am not going to get them and therefore I have got to make the best of a bad job and do what I can with the machine tools I have at my disposal.

Generally speaking as regards the war situation, we have the men, we have the strategic and tactical brains to operate those men, but without the weapons of war we are absolutely powerless and therefore I feel that the inauguration of this Section of the Institution of Production Engineers is a most important thing because by the pooling of production engineers' brains, by compressing them into an executive capacity by the will of the membership and by talking over all the difficult problems which we have to solve in war production, a very great deal can be done to solve these problems. I can assure Lord Sempill, if he does not know it already, as I expect he does, that the Belfast Engineers are second to none, and that, therefore, if you gentlemen pool your brains you may not only be of assistance to yourselves in the production of war material of a very essential character, but for all you know you may think out some solutions to the difficulties which exist on the other side of the Irish Channel, and therefore you might possibly be doing the greatest possible service to the war effort throughout the Empire by taking a real active interest in the Institution of Production Engineers. I think therefore on these grounds that this Inauguration this evening is a very important event in the history of the Province and I feel sure that everyone of you will do your utmost to support the executives which you have elected this evening. I am confident in fact that this Inauguration will be of great value to the war effort. (Applause).

The General Secretary

MR. RICHARD HAZLETON, General Secretary to the Institution, said: I am not here to make a speech—my speech-making days are over—they belong to that dark past hinted at by our Chairman to-night. I have come here to see Lord Sempill, Sir Basil Brooke, the Speaker and the others do their stuff from this platform, and to see your response to their appeal. After thirteen years experience

as General Secretary of this Institution I can safely say that this Inaugural Meeting is the best Inaugural Meeting we have yet had.

I would like to thank Mr. Brown for his kindly references to Mr. Marsden and myself. It was a happy accident that after getting his Commission in the Army, Mr. Marsden was posted to Belfast, which enabled him to be of service in interesting you here in the work of the Institution and in promoting the formation of this Northern Ireland Section.

In this new section of the Institution you have an instrument in your hands which can be of great national service, but it can only be so if you use it as it should be used. We at Headquarters and the branches throughout Great Britain and elsewhere, who share your sympathies and interests, will do what we can to help you. From the spirit that has been shown here to-night I am confident that this Northern Ireland Section of the Institution will be a great success.

I will conclude by asking you to adopt a cordial vote of thanks to Lord Sempill for his address to-night, to Sir Basil Brooke and the Speaker, to the Vice-Chancellor of the University for his kindness in housing this meeting to-night, and to Mr. Brown for presiding over the meeting.

The resolution was adopted by acclamation .

The Vice-Chancellor of the University

MR. DAVID LINDSAY KEIR, M.A., Vice-Chancellor, Queen's University, said : May I in a few very brief words endeavour to thank you one and all for the most kind way in which you have received this vote of thanks. I do so, if I may, in the name of the others who have been associated with myself and with the University in what has been said.

I have been at many meetings within these walls, but never before have I felt greater interest, pleasure and encouragement than I have experienced in your company this evening. We in the University are proud that our Great Hall has been the scene of this ceremony. It is of great moment for us as well as for you that the Northern Ireland Section of the Institution of Production Engineers should have been inaugurated within the University, and I should like, and I may speak here in the name of all my colleagues in this place, to express the hope that we shall see you here again in equal numbers, and if such a thing is possible, with even greater enthusiasm than has been shown this evening. I should like to give you our most cordial good wishes for the success of this section.

One word more. I said that never had I experienced a greater feeling of encouragement than to-night. We in Ulster know that in our hands, in trust to us, are some of the essential keys of victory.

I am sure that none of us will go from here without the reassuring feeling that we have learned much about how we can best use them. What we have begun here in company with one another is going to be of immense value to our city and province, as to our country, in the great effort which we are making together in these anxious and arduous days. We know that great responsibilities rest on us and we have been given much useful light as to how we can most effectively do our part in winning the war.

Looking beyond that point, just for one moment, to the broad vistas of prosperity for us and our fellow-citizens which will follow the day of victory, I am sure I am expressing what is in the minds of us all when I say that what we have initiated here to-night will be of enduring service to this great community of ours in peace as well as in the war's ordeals. Thank you very much, and, once more, the very best of good wishes to you in your work in the newly-established section. (Applause).

Concluding Speeches

MR. D. H. ALEXANDER, Principal, Belfast College of Technology and Hon. Secretary of the New Section, and 2ND LIEUT. MARSDEN, Assistant Secretary to the Institution, also briefly addressed the meeting.

The proceedings then concluded.

THE OPERATION AND TOOLING OF SINGLE SPINDLE AUTOMATICS

Paper presented to the Institution, Birmingham Graduate Section, by J. H. Bailey (Graduate).

Synopsis.

(1) Introduction.
(2) Operation of Machines.
(3) Attachments—Description and Use.
(4) Special and Standard Tools—Description and Use.
(5) Design of Cams.

Part I.

In giving this paper, I am going to specialise in one type of single spindle automatic machine only, namely, the Brown & Sharpe, Index and B.S.A. type, in which the turret is mounted on a horizontal axis. This type with two or three cross slides and various attachments is acknowledged to be the most universal

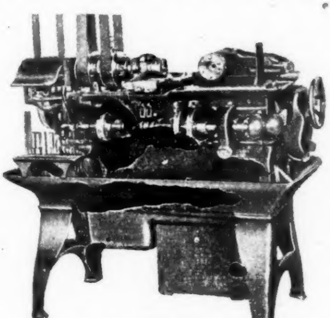


Fig. 1.

and versatile type so far evolved. I am confident there are many graduates and even older members who wish to know exactly how these machines are operated and tooled, and I hope those members who are very conversant with automatics will excuse me if I appear to go into details concerning parts which to them may appear so elementary. Here is a modern B. & S. automatic (Fig. 1) and an Index automatic motor-driven (Fig. 2).

Part II.

The general principles of these automatic machines are quite simple. A bar of stock is held firmly in a collet in the spindle and rotated. Various tools for working on it are held in a circular turret which is mounted with its axis horizontal. This turret is advanced automatically towards the work spindle, and withdrawn and rotated through 60° anti-clockwise after each tool has finished its operation, bringing all the six tools or however many are used into operation one after the other.

Two or sometimes three independent tool slides moving at right angles to the spindle carry tools which automatically advance and work on the bar of stock.

The rotation of the spindle is reversed and the spindle speed changed automatically for different operations as desired. After each piece has been completed and cut off, the bar is advanced

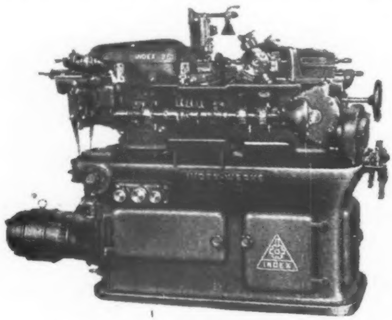


Fig. 2.

automatically to a stop placed in the turret, and the operations repeated to make another piece until the bar has been used up.

Power is transmitted either by belts from overhead works to a pair of friction clutch pulleys for driving the spindle and a belt to drive a third pulley and the backshaft at a constant speed, or as shown on the present illustration, from a constant speed motor over intermediate transmission gears to the main driving shaft of the gear box arranged in the base of the machine which is provided with an automatically operated speed change friction clutch. The workspindle being driven by two roller chains is provided with a spindle reverse friction clutch. The sprockets of this clutch are provided with hollow friction cones running in opposite direction.

The backshaft arranged at rear of machine is driven from the main driving shaft by a crossed belt. The hand-operated clutch is for starting and stopping the backshaft independent of the spindle.

The backshaft can also be operated slowly by a hand-wheel situated at the other end of the machine. From this shaft, power is carried through change gears, and worm and worm wheel or bevel gears to the cam shaft on the front of machine. This shaft carries the disc cams for operating the cross slides, and carriers holding adjustable trip dogs. As the shaft rotates, these dogs engage trip levers which pass through the machine and throw in clutches on the backshaft which operate, first the opening and closing of collet and feeding of bar through spindle, second the reversing of spindle, third the changing of the spindle speed, and fourth the indexing of the turret.

The next illustration shows the operation of these clutches. (Fig. 3).

The dog clamped to the carrier on the front cam shaft lifts the lever which depresses the pin *B* allowing the spring loaded dog clutch to engage. The cam *Z* 5 holds the lever down while the

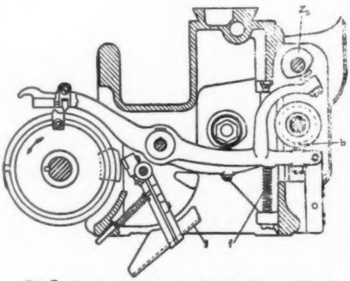
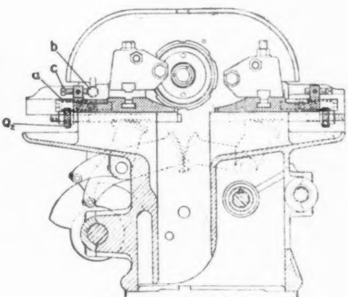


FIG 3 ARRANGEMENT OF LEVERS, CLUTCH, CAM, ETC

Fig. 3.



Cross slides and method of operation

Fig. 4.

backshaft completes the two revolutions necessary to operate the various mechanisms. Without this cam, the spring-loaded lever would cause the clutch to be thrown out after one revolution.

The work chute *G* is also operated by a trip dog, and as the work is cut off, it swings forward dropping the component into a tray.

Each of the cross slides is operated by a lever, one end bearing on the cam with a roller, and the other end having a segment gear engaging a rack on the slide. Coil springs in the cross slides force them away from the work when the lever comes to a drop on the cam. The next (Fig. 4) illustrates this clearly, showing the front slide in the forward position with the roller on top of the cam, while the rear slide is in the back position with the roller on the bottom of the cam. The slide return spring is shown at *A*, the posi-

tive stop *C* adjusting stop screw and slide adjusting screw at *Q* 2.

The backshaft always runs at a constant speed and the time for advancing bar, opening and closing collet, indexing turret and changing speed remains the same, regardless of the speed of the spindle or time to make one piece. The time taken for these operations varies according to machine from one-quarter second to one second.

The rate at which tools are fed to the work and the time taken to make one piece depend on the design of the cams and the speed

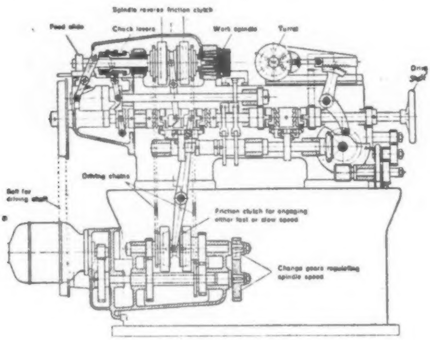


Fig. 5.

of the camshaft which is regulated by the change gears on the end of the machine, both of which are governed by the component. Usually one revolution of the camshaft is taken to make one piece.

The bar of stock is gripped by a spring collet located at the front of the spindle. It does not move endwise, but has a tapered sleeve forced over it, and is prevented from moving forward by the nose cap nut of machine. When the collet opens the stock is pushed through by a spring feed finger screwed into a feed tube and located directly behind the collet, which permits using bars up to very short lengths.

The movements of the feed tube and the sleeve which closes the collet are controlled by a cylindrical or barrel cam, having two races or two cams keyed together on the same shaft so that the movements are synchronised and cannot get out of time. This barrel cam is rotated through gearing from the backshaft when the clutch is engaged as previously mentioned.

The next (Fig. 5) shows a diagrammatical layout of a modern chain drive Index automatic.

You will see how the drive is taken from the motor through gears straight through to the two change gears on the extreme

right, the top one of which drives directly either one of the two top gears depending on the position of the clutch. On this illustration the clutch is shown on the left, so that the left chain driving the spindle is being driven directly from and at the same speed as the top change gear, while the right chain is being driven at a much faster speed in the other direction by the intermediate gear below. When the clutch is thrown over to the right, the right hand chain is driven directly by, but not at the same speed as the top change gear, because the sprocket is situated on the bottom gear, the top one acting as an intermediate, again as this sprocket and the bottom

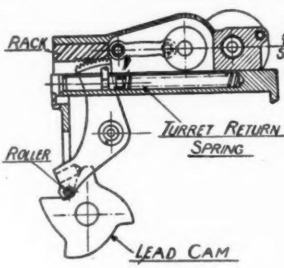


Fig. 6.

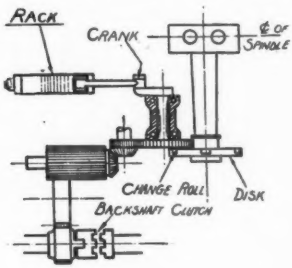


Fig. 7.

left hand intermediate are integral, the left hand chain is driven at a slow speed, namely, one half.

By this arrangement two right hand and two left hand speeds are available, the bottom clutch changing the speed and the top clutch changing the direction. There are eight variations of these four speeds through the medium of change gears.

The back shaft is driven by a crossed belt and has five dog clutches for operating the mechanisms I have previously mentioned.

The turret is mounted with its axis horizontal so that it does not interfere with the cross slides or tools when they are close to the work. After each turret operation, it is indexed round by means of a change roll engaging in radial slots in a disc on the rear end of the turret shank, which is tapered and forms a bearing in the turret slide. The indexing movements are thus made very rapidly, and without appreciable shock. The turret is locked in position by a taper pin between indexing, this being automatically withdrawn when the indexing mechanism starts to operate. It can, of course, be withdrawn by hand for setting up purposes. The quick advance and return of the turret is operated independently of the lead cam by means of a crank as shown in Fig, 6.

The cam causes the lever to move the rack forward when the crank is in its normal straightened out position and the next (Fig. 7)

shows that when the dog clutch on the back shaft is engaged by gearing, the crank makes one revolution, and the hardened roll engages in radial slots in the disc on rear end of turret shank and rotates the turret through 60°, but also as the crank revolves, the turret return spring forces the turret back without moving the rack and therefore quite independently of the lead cam. The exception to this being, that when the turret is in its extreme backward position before the mechanism operates, the turret remains stationary while revolving, the rack is moved forward and the lead cam lever is lifted off the cam.

By using two change rolls instead of one, it is possible to index round two holes instead of one.

Part III.

Before describing any examples of tooling, it is necessary at this stage to describe briefly some of the more widely used attachments, which are not considered part of the original machine, but which are indispensable for increasing production and lowering costs, in particular the elimination of second operations is a consideration that cannot be too highly stressed.

The attachments can be grouped in three sections. In the first are those which are used on the machine as auxiliaries or tools for special work, all of which in conjunction with the usual equipment operate on the bar of stock when it is held in the collet, that is before it is cut off.

Secondly, there are those attachments which perform second operations on the finished component in a separate mechanism after it has been cut off, that is to say, an operation is performed on a piece by these attachments while another piece is being machined and cut off.

In the third group are those attachments which do not interest us to the same degree, and which I shall not describe to-night, namely, chip conveyors, bar inserting mechanisms and outside feeding attachments, to increase the range of machines, etc.

In the first group we have first of all the third slide. This is a vertical slide placed very close to the spindle and used primarily for cutting off by means of a blade tool when the two cross slides are being used for other operations. You will appreciate the usefulness of this slide in machining difficult parts where two form tools are necessary or where one cross slide is used for forming and the other for knurling, etc.

It is operated by a rack and pinion through a lever which is controlled by an additional disc cam, similar to the cross slide cams, placed on the left hand end of the front cam shaft.

As a matter of interest, I would like to say here that an attachment has been designed not unlike the third slide, but in which the tool can move in a longitudinal direction as well as vertical. This longitudinal turning attachment, as we call it, is extremely useful for turning behind shoulders while performing turret operations at the same time. The movements are controlled by two cams, and the results are very satisfactory, so much so, that the B. & S. Co. have paid a considerable sum for the patent.

Secondly, we have the swing stop which is used when all the six turret holes are required for other operations. The stop is usually operated by rack and pinion from the back shaft.

The high speed drilling attachments are used to increase the speed of the drill relative to the work when it cannot be obtained by the normal speed changes.

For example, if a hole of .093 diam. has to be drilled in a component or bar whose outside diam. is .500 on a No. 0 (Regular) B.&S., and if a speed of 1,800 r.p.m. which is the maximum on machine, gives correct cutting speed in feet per minute on the outside diam., it only gives a speed of 44 ft. per minute for a stationary drill. Now if it is possible to drill that material at 150 f.p.m. a revolving drill in the turret running at 3,600 r.p.m. in opposite direction to the spindle will give a better cutting speed, namely, 130 f.p.m. and will decrease the cycle time of the job.

These revolving drills are driven either by a round belt from the overhead works to a pulley on a shaft, which passes through the centre of the turret and connects with the attachment by bevel gears, or on the bevel gear shaft which passes through the turret is driven in turn over bevel gears arranged in a housing, bolted to the turret, from a shaft which is coupled to the driving attachment. This driving attachment is provided to drive the slotting attachment also. It is bolted to the rear side of the headstock and driven by a roller chain from the backshaft.

Another very useful attachment is that used for cross drilling holes through the piece at right angles to the spindle. The attachment is bolted to the cross slide in place of a tool post and driven similarly to the previous attachment. Usually a jig is held in the turret and fed on to the work after the spindle has been stopped by a brake.

The method of applying the spindle brake once again varies with the machine. It may be used on the reversing spindle pulley, in which case if any threading is required a revolving tap or die is used, and driven as the revolving drill. The tap or die, revolving in the same direction as the spindle while threading on, unscrews when the spindle is stopped. Alternatively, the brake may be applied to a special shoe on the rear end of the spindle, operated

by a clutch on the backshaft, which also brings the spindle reverse clutch to the centre neutral position while the shoe is applied.

The cutting of threads behind a shoulder which cannot be screwed from the turret and the chasing of internal and external threads of high accuracy is made possible by the chasing attachment. This attachment is bolted to the front side of the headstock and coupled to the front cross slide. The longitudinal movement of the single point tool is obtained by a lead screw and an engaging shoe or nut, the lead screw being driven by transmission gears from the spindle and the engagement of the nut being controlled by trip dogs and levers. The amount the tool is being continually fed into the work is governed by the design of the front slide cam, the tool being automatically withdrawn away from the work for each return stroke without having a drop on the cam.

All the attachments I have so far described have worked on the piece before it has been cut off. We now come to those in the second group. The one most frequently met with being the slotting attachment.

The method of operating this mechanism varies, but the principle remains the same. Briefly then, there is a saw in a housing fitted to the front of the headstock, a little behind chuck or collet. The saw is driven either by a round belt from the overhead works or from the driving attachments as previously mentioned. Then there is an arm which swings down in between the turret and the work, and as the part is severed from the bar, moves forward, grips the work, swings up to the saw, moves forward on to the saw, and then back so that a thin blade which extends through the work bushing ejects the work into a chute. The longitudinal and swinging movements of the grip arm are actuated by two cams placed on the front cam shaft.

In carrying out this operation, it is necessary to have one empty hole in the turret after the last turret operation, and the latter must finish cutting early enough to allow the grip arm to descend and move on to the piece before it is cut off. That is to say, on a job where the time taken to normally part off after the last turret operation is very small, if that time is not increased, in other words part of feed reduced below normal, the swing arm, to be in position ready for when the part drops off, has to drop down before the last turret tool has had time to index away and leave an empty hole. After the arm has swung up, the bar is fed out to stop, and another cycle of operations takes place while the slot is being cut in the screw, etc., thus saving the time of a second operation, as well as the handling of the parts.

There are variations of this operation, for instance two saws can be mounted on the arbor with a spacing collar between them to mill two parallel flats on the component.

The burring attachment is very similar in operation, the picking up and transferring being identical, while the saw is replaced by a revolving drill, and is used for performing light operations of countersinking or counterboring, or drilling the cut-off end of the piece.

Part IV.

You will all be familar with the majority of operations carried out on these machines, namely, turning, drilling, reaming, tapping and screwing, forming, knurling, and cutting off, etc., but I will just mention a few facts and figures which, although they may not be the last word in perfection, are up to a good standard of efficiency. I trust they will be of interest, or at least form the basis for much argument, and perhaps criticism in the discussion which follows this paper.

Turning is usually done with a roller box or vee steady box tool or a type of knee tool, both radial and tangential types being used. For roughing cuts, hollow mills can be used. It is always advisble to chamfer the end of the bar. This can be done quite easily with the part off tool. If two diameters have to be turned, by turning the largest first, a chamfer is still left on the end of the bar for the next turning tool to start on.

The tolerance that can be generally worked to is approximately .0015 — .0020. In some cases to obtain a better finish without the spiral run-off marks caused by indexing tool the straight off, traversing back is found successful.

When drilling steel or other metals which are not so easily machinable as the leaded brasses, it is necessary to withdraw the drill frequently, as well as reduce the feed, either by dropping the lead cam or by indexing another drill into position, the former being preferable as the rapid approach to the cutting position by indexing is often unsatisfactory and if the second drill is not ground the same as the first running out is likely to occur.

Forming is usually done with a circular tool which is gashed and ground with its cutting edge a given distance below its own centre in order to give clearance. For some materials and finishes, it is, of course, necessary to use a blade tool on which side clearance can be obtained. When facing down the front of large diameter components a blade tool holder can be designed to fit on the standard tool post to be used at the same time as the circular tool. It is practical to form diameters to a limit of $\pm$ .001.

Tapping deep holes on automatics is found impracticable, the maximum depth being approximately a distance equal to the outside diameter of the thread by two and a half for brass, and the core diameter by two and a half for steel.

On one occasion when tapping very thin components in brass, it was found necessary to use a tap with as many flutes as possible, otherwise the outside diameter was comprised of a series of flats instead of being circular.

Screwing can be done either with a button die, in which case the spindle is reversed and the die run off, or with chasers and a self-opening die head, which is caused to pull out and open by the design of the lead cam, and is closed ready for cutting thread when the closing lever on the side of the die holder is brought into contact, while indexing, with a plate fixed to the machine.

Swing tools are used for internal recessing, turning behind shoulders, and turning tapers. They are turret tools and the movement in the direction of the spindle is controlled by the lead cam while

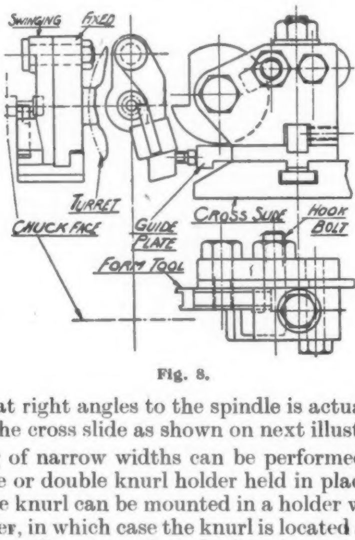


Fig. 8.

the movement at right angles to the spindle is actuated by a pusher plate fitted to the cross slide as shown on next illustration. (Fig. 8).

The knurling of narrow widths can be performed from the cross slide by a single or double knurl holder held in place of the circular form tool, or the knurl can be mounted in a holder which is attached to the tool holder, in which case the knurl is located ahead and above the circular part off tool, so that the knurl passes over the bar of stock and the part off tool follows up and severs the piece from the bar. Knurling from the turret by feeding on to the end of the bar is usually carried out with an adjustable knurl holder that carries a pair of knurls, one on each side of the bar and set parallel to the axis of the work. When it is impossible to knurl from the cross slide and the design of the piece does not permit running on the end, a swing knurling tool is employed.

In addition to these general operations there are one or two

which may not be quite so widely known. First of all skiving. This is done with a tool holder as shown. The cutting blade has the form of the component ground all along its top edge, passing underneath the bar of stock and cutting tangentially. (Fig. 9). The tool holder is simply a block with a slot milled in it to take the blade and held together with a top plate down on the cross slide by the

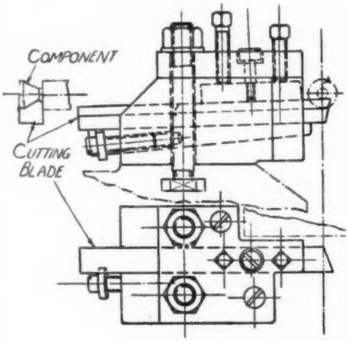


Fig. 9.

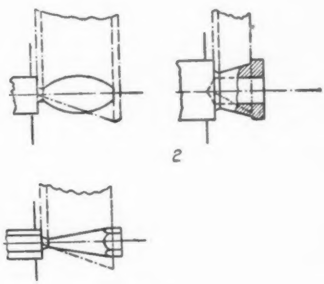


Fig. 10.

two bolts. The blade being held rigid by the clamps and two set screws, the centre screw is only to roughly position the clamp. Adjustment for height is made by the adjusting screw and a tapered wedge. The view on the left is simply a front elevation of tool and component only.

It is used on the cross slide in place of a form tool and is especially useful in cases where the ordinary form tool would have to form the bar down to a very small diameter at the chuck end before the whole of the forming cut takes place.

By grinding the front of the skiving tool at 20° this condition is removed as will be seen from the examples shown. Here the largest diameters and those farthest from the chuck are formed before the smaller diameters near the chuck are reduced and while there is enough metal to prevent the bar from breaking off before it is finished. A steady is sometimes used either from the turret or the rear cross slide as the tools tends to force the bar upwards. (Fig. 10).

These three illustrations show the plans of the skiving tool in chain dotted lines, and how the tool passing underneath, cuts and reduces the diameters furthest from the chuck before reducing the weak diameter nearest the chuck. The thick black line cn left represents the chuck, and the job in this case is running in a

forward direction. If these jobs were formed, the whole cut could be taking place when the bar was weakened.

A skiving tool will give a better finish and a finer limit than forming, approximately $\pm$ .0005.

A shaving tool as illustrated in the next illustration (Fig. 11) will shave parts to a still finer limit, approximately $\pm$ .0003. In this tool the work passes between a cutting blade and an anvil which has a radius on its front edge. It is used as a finishing operation only, the diameter to be shaved being previously rough machined to within about .005.

The rolling of threads and other forms on brass and other soft materials is often carried out successfully on automatic machines.

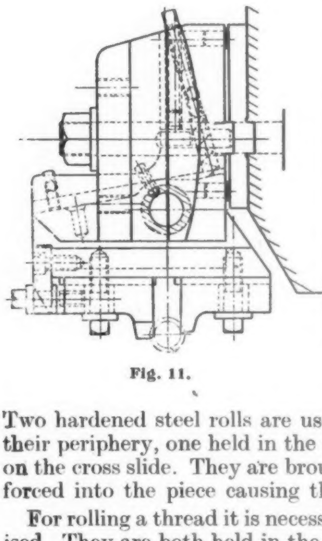


Fig. 11.

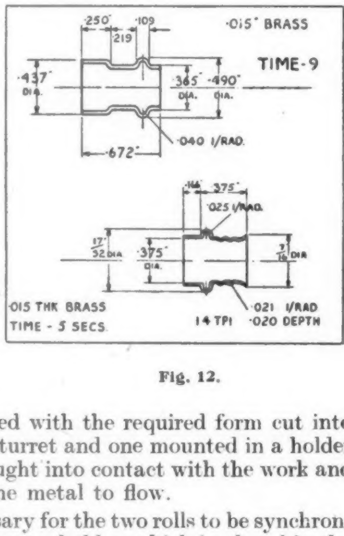


Fig. 12.

Two hardened steel rolls are used with the required form cut into their periphery, one held in the turret and one mounted in a holder on the cross slide. They are brought into contact with the work and forced into the piece causing the metal to flow.

For rolling a thread it is necessary for the two rolls to be synchronised. They are both held in the same holder which is placed in the turret, and geared together. Both the rolls can swing independently, one being operated by the front slide and one from the rear.

The two examples of rolling shown are typical. You will recognise the flashlamp bulb holder. (Fig. 12.)

An unusual operation for these machines is broaching, and while the scope is, of course, very limited, in the brass example illustrated it was successfully carried out with the tool as shown in the next illustration. (Fig. 13).

In Fig. 14 you see the tool very nearly at the finish of its cut by the time it has reached the undercut in the tube, the lever A is forced by the adjusting screw anti-clockwise, sufficient to allow the closing

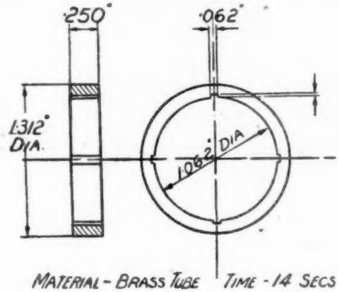


Fig. 13.

lever B pivoted at X to also move anti-clockwise. The strong spring forces the shaft C to the left and this allows the collet type of broach to close in, when it can be quickly indexed out. At the beginning of the operation the tool is indexed into position $\frac{1}{4}$ in. to the right, while the bar is stopped and the cross slide moves forward until the block D forces the lever B anti-clockwise sufficient to close

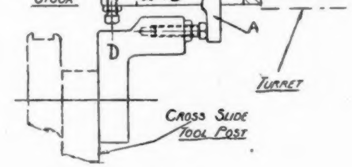


Fig. 14.

broach and allow catch on lever A to hold in position, the lever A being spring loaded. The cross slide now drops back about $\frac{1}{8}$ in. and the broach moves forward, as I have already explained.

On the next component (Fig. 15) the .276 radius was very important with regard to size and finish required, the latter being unobtainable on a mass production basis with an ordinary form tool or cutter.

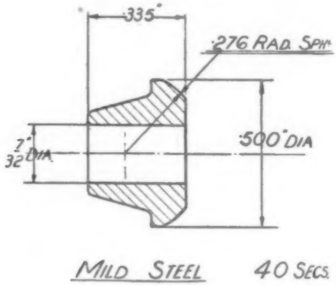


Fig. 15.

A simple tool was made to generate the radius with a single point turning tool, operated by a rack and pinion from the cross slide.

The plug and gauge you see in the centre (Fig. 16) are used only for setting purposes, the diameter of the gauge being in this case twice .276. The tool is indexed into position and the cross slide pushes the rack *A* which engages teeth on the swivelling tool holder and causes it to revolve about the centre, which is on the centre line of spindle and in the correct position over the component.

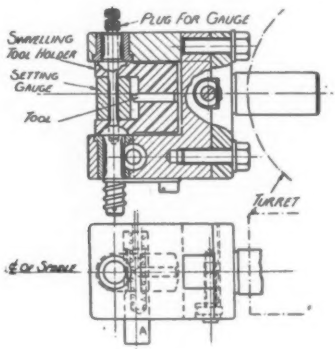


Fig. 16.

The tool is returned, when the cross slide drops back, by two springs.

There are various methods of milling slots or flats on a component from the turret, making use of the bevel gear used for driving the

high speed drill, etc. A circular saw can be driven by gearing, a simple design of attachment being illustrated. (Fig. 17). The spindle is, of course, stopped by the usual brake.

Alternatively a straight saw blade can be oscillated up and down by an eccentric driven as shown. (Fig. 18). In this design the saw

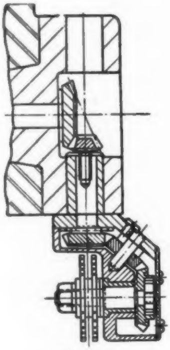


Fig. 17.

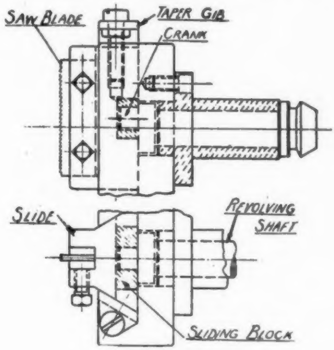


Fig. 18.

is moving slowly forward during the whole of the operation, that is during the return stroke as well as the cutting stroke. Nevertheless it operates very successfully. On the sample I have here to-night, the saw ran at 1,600 strokes per minute with a feed of .001 per stroke,

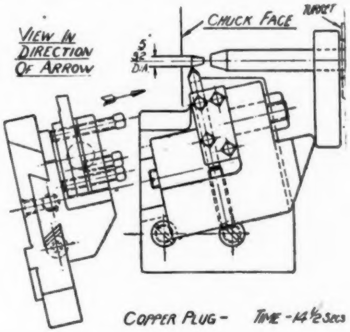


Fig. 19.

cutting an .080 deep slot in three seconds, with a stroke of approximately $^5/_{16}$ in.

The next illustration shows a taper turning slide fitted to the front cross slide. (Fig. 19). In this arrangement the tool is held in

a small holder, bolted to the slide, which is at the required angle and moved forward by the pusher fixed in the turret and returned by a spring in the body of the slide. On this set up, as there were no other turret operations beside turning and feeding to stop, to save time and the wear of the machine in indexing, the stop was placed as shown. It passes right through the pusher and is actually held in the opposite turret hole. At the finish of taper turning the cross slide drops back, the component is parted off, and the turret moves forward to bring stop into position, and afterwards drops back ready for cross slide to move forward into position again.

I am sure, from these last illustrations of a few of the special tools designed for automatics, you will realise the scope of these machines in turning out parts much more complicated than just nuts and bolts, and in a large number of instances without the use of second operations, which until a few years ago were considered an absolute evil necessity.

Part V.

It will be quite obvious that the successful operation of these automatic machines depends not only on the efficiency of the setters, but also on the design of cams and tools, because it is here that the sequence of operations, selection of tools, feeds, and speeds takes place.

Where only a few machines are installed, it may be possible to have each job tooled up by the makers of the machine. If this is impracticable, it is absolutely essential to have the selection and design of the cams and tools supervised by a specialised expert who has a wide knowledge of the machines, attachments, and tools, and what can be expected from them.

In some shops it has been the custom to let the setters sort out an old set of cams from the stores to produce a new job and even if necessary touch them up a little, grinding a bit off here and there and then putting them on the machine, subsequently having very often to slow up the cycle time considerably in order to run the job successfully. While I do not underestimate the ability of setters as setters, and will even agree that they may become efficient at this patching-up business. I am sure you will appreciate the inefficiency of this system, even without me illustrating it in figures, which would I can assure you prove it even more substantially.

You will see how it is essential to have correctly compiled records of all cams in the shop, so that a suitable existing set can be chosen for a new job, which have the necessary amount of travel without any alteration, etc., in order that the original job for which the cams were designed can still, if necessary, be produced. Alter-

natively if an existing set cannot be found or spared, a new set of cams would have to be designed. I think I am correct here in saying that there are surprisingly few setters that can figure out and draw a set of cams, the principle of which I will now briefly describe.

We will take as our example the component shown on the next illustration. Having decided which machine it will go on, and the best sequence of operations, we draw a tool layout showing the turret, tool posts, and tools at the finish of their respective operations. (Fig. 20).

In this case the machine is a No. 00 B. & S. and the operations are first feed to stop, second centre, third drill, fourth turn, fifth

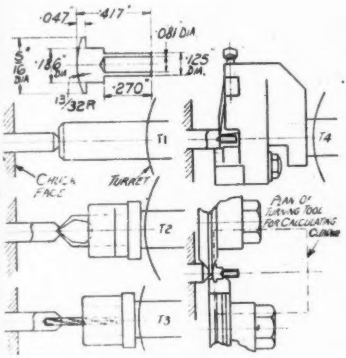


Fig. 20.

OPERATION	TRAVEL	FEED	REVS.			H/THS	H/THS
FEED TO STOP						4	4
INDEX						4	8
CENTRE	·050	·005	10			2	10
DWELL						1	11
INDEX						4	15
DRILL	·200	·003	70			13	28
	·075	·0017	45			8	36
DWELL						1	37
INDEX						4	41
TURN	·280	·0036	75			14	55
DWELL						1	56
CLEAR						8	64
FORM	·100	·001	100			20	84
DWELL						1	85
PART OFF ·126	·068	0025	27			5	90
" "	·030	·001	30			5	95
" "	·028	·002	14			3	98
DWELL						1	99
CLEAR						1	100
	CUTTING →371			IDLE →30			CYCLE
MATERIAL-BRASS-TIME -							

Fig. 21.

form, and sixth part off. For simplicity the cams and thus the cycle times are divided into a 100 parts not 360°.

We now analyse the cutting and idle operations, setting them down on a work sheet as shown on next illustration. (Fig. 21).

Next we calculate the cutting travels required, decide on most suitable speeds, keeping in mind all the operations, decide on the feeds and thus calculate the number of revolutions for each cutting operation. From the machine tables we find the number of revs. for indexing and feeding to stop. At this stage we put down the idle hundredths for dwells and clearances, etc., in order to graph out the clearances it is necessary to approximate the time for the job.

Now if we add together all the idle hundredths which we have down at the moment, subtract from 100 and divide the result into the total number of revolutions we have, we obtain the total number

of revolutions to make one piece. From the tables we find the nearest figure obtainable by the gearing, and thus obtain the time per piece.

We can now put down the number of hundredths required for indexing, feeding to stop, and all the cutting operations by dividing the number of revolutions for each operation by the total revolutions per piece and multiplying by 100.

In actual practice it is not always so simple as I have explained. There are many complications, snags, and pitfalls which I have not time to explain to-night, but which one soon meets when commencing to design cams.

Before explaining the principles used in drawing the cams I will recall to you the operation of the turret and slides. You will remember how the cam lever, one end bearing on the cam with a roller and the other having a segment gear engaging a rack on the tool slides, is caused to move by a rise or lobe on the disc cams. The actual rise on the cam giving the travel of the tool, the number of hundredths of the cam surface during which this rise takes place is calculated as I explained a few moments ago.

Now the outside diameter of each cam blank is standardised according to machine, but each lobe may not necessarily finish on the outside diameter. Referring to the lead cam, to which these last remarks are mostly concerned, we find from the various machine handbooks that when the lever roll is on top of the cam the turret is a given distance from the chuck, so that from our tool layout on which we positioned the turret for each operation we can find how much it is necessary to cut down the cam for each operation. To explain more fully, let us take the example which has already been worked out.

On the No. 00 B. & S. machine the minimum distance from turret to chuck when the roll is on top of a 5 in. diam. cam is $1\frac{7}{8}$ in. for the first cutting operation. We want the turret to finish $2^3/_{16}$ in. from the chuck, and it will therefore be necessary to cut the centring lobe down $^5/_{16}$ in. The amount of cut down for all the lobes is found in a similar manner.

I would like to mention here that some firms draw out all the cams for one job on the same centre, superimposed on each other. One cam outline being drawn with a dotted line, one with a chain dotted line, and the other with a full line. They claim that by this system you get a clear idea of the sequence, overlapping, and position of the different tools.

While agreeing with this in principle I think that in some cases it would tend to become rather confusing and I therefore prefer to draw out each cam on a separate centre. After all, it is still quite easy to tell what is happening to each of the slides at any given point.

In any case it is necessary to have the circumferance of the cam circles on the cam sheet divided into a 100 equal parts or alternatively to have a master chart which can be placed underneath the cam sheet and be seen clearly through the drawing paper used.

In the next illustration you will see what the finished drawing of the lead cam for the component we have already seen should look like. (Fig. 22).

The cross slide cams for a B. & S. auto are in most cases drawn with lobe on top of cam, because there is plenty of adjustment to compensate for the distance the tool finishes from the centre of the

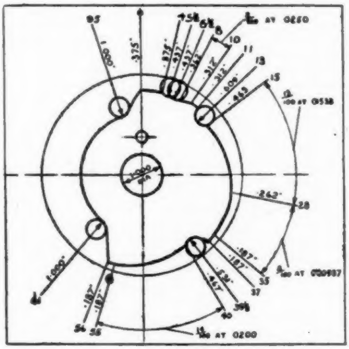


Fig. 22.

spindle. On the index machines, this is not the case, and the cam lobes are cut down an amount equal to half the smallest diameter that the form tool is cutting.

There is one very interesting application of these machines which I should like to mention. I refer to their use for second operations. I realise that the economy of using them for such probably causes many arguments and headaches. This is quite a natural trend. After all, the economical use of these machines even for first operations, has always aroused much criticism and arguments, and the seeking of that elusive unknown quantity where it pays to change from capstan to auto even if left to a number of highly skilled engineers would give a surprisingly varying result. To-night let us leave that question and see how the machines can be applied to this type of work.

The usual method of loading is usually by a magazine which may be situated on various parts of the machine according to the nature of the work or operations to be performed. For instance, it might take the place of the third vertical slide, one of the cross slides, or even be placed at the rear end of machine.

To illustrate I will briefly describe two examples. In the first, the components are held in a vertical magazine designed just to take the components, one above the other, the actual number depending on the cycle time of the job and what other task the feeder will have to do or how many machines he has to feed. The actual cycle of operations for a job of this nature might be as follows.

First the cross slide on which the magazine is bolted moves forward until the bottom component in the magazine is in line with the spindle. The collet is then opened and a spring loaded pusher held in the turret moves forward under the influence of the lead cam, and pushes one component into the collet up to a stop. The collet is then closed, the pusher withdrawn and indexed, while the cross slide is withdrawn.

Operations can now take place from the other slides and turret and on completion the collet is opened, component ejected by spring pressure, and another cycle of operations commences.

It is not always possible to place the magazine close to the spindle. For instance all the slides may be required for cutting operations, and in this case it is sometimes convenient to place it at the end of machine furthest from the collet. There is a very useful facing with tapped holes at this end of machine to which a magazine can be bolted, designed to bring the component exactly in line with the spindle, but of course behind the turret, that is to say, with the turret in between the collet and the job. By fitting an additional cam by the side of the lead cam, which can be made to move a lever, it is possible to push the component on to a spring loaded snug situated in the turret. The latter is then indexed three times, which brings the component close to the chuck, when it can be loaded into the collet by moving the turret forward.

You will have seen from these very brief remarks the endless possibilities of doing second operation work and, having decided that it will pay, the equipment, tool, and cam designing is one of the most interesting sides to automatic machine work.

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Industrial development.

Formation and development of manufacturing organisations.

Sales organisation. Types for different products. Market study in relation to technical development. Price determination. After service.

Design organisation. Designing for production. Control of quality in designs. Organisation of the design department and flow of work. Relationship of research to design. Organisation and control of inspection activities.

Production organisation. The organisation and interrelationship of the sections concerned with planning, estimating, ratefixing, tool design and manufacture, material purchase and inspection, stores, manufacturing, progress, wages, costing, works engineering, labour bureau, welfare and canteens. Routes of essential documents through the organisation and of work through the shops.

Factory layout. Ideal layouts of works and offices, based on work and document routing. Practical modifications.

Factory sites. General considerations as to suitability of land, service and local goverment regulations. Proximity to materials, labour, markets and communications.

Management. The art of directing human activities. Application of scientific method to management by reference to work of pioneers. Social responsibilities of management (a) to the community (b) to those it directs. Position of management relative to Capital and Labour. Training for management, relative values of theory and experience. Graduation of potential manager through operative and staff grades. Selection of staff; qualities. Modification of theoretical organisations to take account of individuals.

Labour. Trade Unions; their development and legal status. Trade union regulations regarding employment. Negotitations with unions. Works committees. Shop stewards. Selection and training of operatives. Vocational guidance tests. Apprenticeship

schemes. Engagement of labour. Labour turnover. Discharge of labour. Discipline and handling personnel. Effects of long hours and monotony on efficiency. Attitude of labour to status and working conditions.

Industrial legislation. Review of the development of Industrial Legislation the underlying aims and objects. The Factories Act. Detailed knowledge of the current Act and of the more important Statutory Orders insofar as the engineering industry is concerned. Workmen's Compensation Acts.

MOTION AND TIME STUDY

Development. The works of Taylor, Gilbeth and others. Modern Systems of motion investigation.

Relationship of Motion and Time Study.

Motion Study. Its scope. Extent of profitable use.

Methods of measuring. (1) Process Chart, which measures the job as a whole and its route through the factory. Description of various types of Process Charts, e.g., Flow-Charts, two-handed detailed Process Charts, etc.

(2) Micromotion Photography, for the examination of motions making up an operation. (a) Elements of motion (Therbligs), (b) Camera clocks and other time measuring equipment, (c) Films : technique and analysis, (d) Simultaneous motion cycle charts, (e) Improved methods and development generally.

(3) Chronocyclegraph Study, for the measurement of the path of motion. (a) Lighting equipment, (b) Camera and viewers, (c) Chronocyclegraph analysis and type of reading obtainable, (d) Extended use of Chronocyclegraphs for training, measurement of dexterity.

The principles of motion economy. Elimination of unnecessary sources of fatigue. Influence on the designs of tools, jigs, fixtures and equipment.

Time Study. Analysis of typical manufacturing and assembly operations. The technique of Time Studies. Mechanical devices. Use of special stop watches and slide rules. Determination of Rating Factor, allowances and time standards. Development and use of formula for estimating operation time.

Wage Incentives. Relation of motion and time studies to wage incentives. Determination of operation time and allowances. Wage incentive systems ; piece work ; Halsey, Halsey Weir, Rowan, 100% premium, Taylor and other systems.

Training Operators. Application of motion study to improvement in methods. General training of new workers and specific training

for changes of method. The above should be accompanied by an adequate scheme of laboratory work.

PRODUCTION CONTROL

Introductory. The objects and trend of the application of scientific method as an aid to management. Measurement of production efficiency. Control of production.

Charts and Graphs. Compilation and uses of different types. Circle charts. Organisation charts. Use of symbols. Bar charts, simple and compound. Z charts. Divergence charts. Use of semi-logarithmic paper. Gantt charts. Nomograms. Application to the functions included below.

Product designs and drawings. Consideration of drawings, specifications, assembly lists and schedules as a means of conveying information and instructions to the producers. Methods of identifying components, assemblies and drawings. Variations to suit different types of product. Standardisation and use of standard components. Standards of finish. Prototypes.

Planning, Estimating and Ratefixing. Planning as a fundamental of management science. Planning to meet production programmes. Modification of designs to facilitate production. Control of production and measurement of its efficiency by Operation Layout Sheets which specify processes, route, estimated production times, quality of labour, tools and plant required. Layout of shops and provision of handling and transporting equipment to meet specified requirements. Purchase of machine tools on production performance. Research into new production processes. Application of Time and Motion study and use of the data arising when estimating and rate-fixing. Estimation of material requirements. Machining allowances. Elimination of waste. Ratefixing. Economical batch sizes.

Jig and Tool design and manufacture. Use and listing of standard tools. Authorisation and ordering of jigs and tools. Progressing of design and manufacture to meet target dates. The toolroom as a self-contained unit. Demonstration, issue and servicing of jigs, tools and gauges. Tool stores. Tests of proprietary tools. Records.

Material Purchasing. Production and service materials, Specifications, codes and sources of supply. Alternative supplies. Price curves. Records and routine from purchase to consumption. Purchasing for stock and against production programmes. Running contracts. Deliveries into bond and release by inspection. Inspection notes. Office routine.

Stores. Record systems. Functions of Stores Department, receiving, storing and issuing. Perpetual stock inventory. Maximum and minimum stocks. Division of stores, e.g., into raw materials, components, finished products and Service stores, methods of booking material, direct and indirect. Pricing of requisitions. Stock accounting.

Manufacturing Departments. Works and shop orders. Work labels. Job tickets.

Progress. Maintaining scheduled programmes. Control boards and Progress charts. Records of progress.

Wages. Wage abstracts and analyses; prevention of fraud. Methods of remuneration, how calculated, their effect upon production. Timework, piecework, premium and other bonus schemes. Profit sharing and co-partnership.

Labour. Methods of recruitment. Adequate supply. Statistics. Records of employees. Methods of booking labour, both direct and indirect, including time sheets, job cards and bonus cards. Timekeeping; recording systems.

Works Engineering and Services. Factory buildings; special features in structural design. Lighting, heating and ventilation. Power supplies and tariffs. Maintenance of plant, buildings and services. Recording of work done and services supplied.

Costing. Engineering cost accounts, incorporating estimated and prior costs for comparison. Standard costs. Records of costs. Recording of wages and material in costs. On-costs or overhead expenses; methods of absorption and recovery; compositions, ascertainment, treatment and examination of (a) Production overhead expenses, (b) Administrative expense, (c) Selling expense, (d) Distribution expense. Valuation and depreciation, methods adopted to ascertain life and value of plant, machinery and other fixed assets. Taxation and insurance rates. Disclosure of inefficiencies. Mechanical methods of accounting.

Financial Control. General review. Financial control by authorisation and budgets. Control of expenditure. Treatment of capital expenditure. Repairs, renewals and replacements. Allocation of interest, depreciation and other charges under various conditions. Cost control accounts.

ELECTRO-TECHNOLOGY FOR MECHANICAL AND PRODUCTION ENGINEERING STUDENTS

The purpose of this syllabus is to give the Mechanical and Production Engineer a knowledge of fundamentals sufficient to enable him to select and specify industrial electrical equipment and to use

electrical power and equipment efficiently and economically. It is assumed that at least 100 hours will be given to the subject.

Effects of Current. Application of effects to measure current; the ampere. The ampere hour.

Voltage. Current flow as an effect of voltage. Voltmeters, the volt.

The Electric Circuit. Relationship between voltage and current. The ohm. Circuits of "constant" resistance. Effect of temperat-ture.

Energy and Power. Power as product of voltage and current. The watt, kilowatt and kilowatt hour. Relationship to mechanical and heat units.

Magnetic Effects. The Magnetic field. Use of fluxmeter. Effects of iron. Ampere turn-flux relationship for air and for various kinds of iron. Flux-linkage. Electro-magnetic induction. (Mutual and self). Energy in magnetic field. Dynamo-electric effects.

Electrostatic Effects. Relationship between charge and voltage of a condenser. Capacitance definition. Energy in electric field of condenser.

Alternating Currents. Frequency, wave-form, amplitude, mean and r.m.s. values. Vector representation of sinusoidal quantities. Phase. Power conveyed by single phase supply. Power-factor. Elementary 3 phase circuit. Star and delta connexion. Three phase power.

Elementary Treatment of A.C. Circuits. Voltage and current. Relationships of simple circuits containing R, L and C. Effect of frequency changes. Impedance. Reactance. Resonance.

Sources of Supply. Primary cells. Secondary cells. Alternator, single phase and three phase. D.c. generator. The Commutator. Methods of field excitation. Characteristics. Control of voltage and frequency.

Motors. D.c. Shunt, series and compound. The rotating field. A.c. motors, induction and synchronous. Small single phase motors. Speed-torque characteristics. Need for and arrangement of starters. Reversal and speed control. Efficiency; costs. Principles of protective devices: overload with time element, no volt. Thermostatic. Phase sequence and phase continuity, emergency stops.

The Transformer. The a.c. transformer. Three phase connections. Auto-transformer. Full load regulations on non-inductive, inductive and capacitative loads.

The Rectifier. Principles of "Metal," Mercury arc, and hot cathode rectifier.

Systems of Supply. Brief discussion of various systems of supply with reference to the characteristics of the plant to be operated.

Supply and Control Arrangements. Thermal Loading of cables and volt drop. Fuses. Methods of charging for supply ; flat rate ; maximum demand ; load factor ; power factor. (Principles of power factor correction). Metering arrangements, for supply contract purposes and for factory costing and control.

Electric Lighting. Electric lamps. Importance of selection of lamps and fittings to meet standard E.L.M.A. illumination requirements for various types of work.

Special Applications. Electrical supply requirements for special applications such as electro-deposition, electric-welding, and heat treatment.

Safety Precautions. Shock. Fire. Corrosion. Earthing of system. Earthing of metalwork. Protection against overload and leakage. Discharge of capacitative apparatus. Treatment of shock. Rules governing use of electricity and apparatus. Reference to Home Office, Electricity Commission, Board of Trade, I.E.E., and B.S.I. codes.

Laboratory Work. Adequate demonstration and individual experimental work should be done throughout the course.

SUMMARY OF APPROVED SCHEMES FOR THE HIGHER NATIONAL CERTIFICATE IN PRODUCTION ENGINEERING IN ENGLAND AND WALES

EAST MIDLAND EDUCATION UNION

Evening course

*A.*1 (*First Year*)	*A.*2 (*Final Year*)
Properties and Strength of Materials and Metallurgy. Theory of Machines and Machine Tools, Jig and Tool Design and Metrology.	Any three if the following— Jig and Tool Design. Metrology. Machine Tools. Metallurgy. Press and Sheet Metalwork. Plastic Technology. Press work—Plastics. Welding Processes. Hot Stamping and Forging. Foundry Processes.

KEIGHLEY TECHNICAL COLLEGE

Evening Course

*A.*1 (*First Year*)	*A.*2 (*Final Year*)
Properties and Strengths of Materials and Metallurgy—1¼ hours and 1 hour laboratory work per week. Theory of Machines and Machine Tools—2¼ hours per week. Jig and Tool Design and Metrology (Technical Measurement)—2¼ hours per week.	Jig and Tool Design—2¼ hours per week. Machine Tools — 2¼ hours per week. Metrology (Technical Measurement) —2¼ hours per week.

Conditions of admission. Minimum age of entry 18 years. Students must possess an Ordinary National Certificate in mechanical engineering or have otherwise reached a similar standard of attainment.

	1*st Year Evening*	2*nd Year evening*
Hours per week	6¾*	6¾*
,, ,, session	189	189

* In peace time the hours would be 7½ per week.

NORTHAMPTON POLYTECHNIC INSTITUTE
Finsbury, London
Evening Course

A.1 (*First Year*)	*A*.2 (*Final Year*)
*Engineering Chemistry—1 hour and 1½ hours laboratory work per week. †Electricity—1 hour and 1½ hours laboratory work per week. *Workshop Technology (No.156)—1 hour per week. †Workshop Technology (No.154)—1¼ hours per week. *Physics of Engineering Materials—1¼ hours per week. Applied Mechanics—1 hour and 1½ hours laboratory work per week.	‡Materials Workshop Technology ‡Engineering Metallurgy ‡Electrical Technology. } 1 hour and 1½ hours laboratory work per week.

*First half session. † Second half session. ‡ Two of these to be taken.

Conditions of admission. Students must have either completed the corresponding Senior part-time Course or the equivalent. In general, the age of entry will accordingly be 21 years.

	1st *Year Evening*	2nd *Year Evening*
Hours per week	7½	7½
,, ,, session	225	225

UNION OF LANCASHIRE AND CHESHIRE INSTITUTES

Two Year Course for students who have previously taken Workshop Technology

A.1 (*First Year*)	*S*.3
Mathematics and Strength of Materials. Theory of Machines. Workshop Technology.	Workshop Technology and two of the following— Jig and Tool Design. Machine Tools. Metrology.

Alternative Three Year Course for students who have not previously taken Workshop Technology S.3.

A.1 (*First Year*)	*A*.2 (*Second Year*)	*A*.3 (*Final Year*)
Mathematics. Strength and Elasticity Materials. Workshop Technology S.3.	Theory of Machines. Workshop Technology one of the following : Jig and Tool Design. Machine Tools. Metrology.	Workshop Technology and two of the following : Jig and Tool Design. Machine Tools Metrology.

Research Department: Production Engineering Abstracts

(Edited by the Director of Research)

NOTE.—*The addresses of the publications referred to in these Abstracts may be obtained on application to the Research Department, Loughborough College, Loughborough.*

ANNEALING, HARDENING, TEMPERING.

Oxyacetylene Flame Hardening, by J. G. Magrath. (*The Machinist, Nos. 15—18*) : **Gears and Racks**, *No. 15 (May 23, 1942, Vol. 86, No. 6, p. 54, 11 figs.)*.

A flame-hardened gear tooth surface, properly treated, has nearly twice the wearing load-carrying capacity as that of an unhardened gear. It is doubly essential that flame-hardened gears be correctly aligned. Depth and contour of hardened area are subject to differences in opinion but in general are a function of the diametral pitch. Table on influence of flame speed on hardness. Speed decreases depth. Bevel, spiral bevel, zerol bevel and hypoid gears are best flame hardened on machines provided with automatic indexing, variable speeds and curvature cams. Flame-hardening unit for treating medium and large gear teeth.

Sprockets, Threads, Worms and Sheaves, No. 16. (*June 13, 1942, Vol. 86, No. 9, p. 107, 10 figs.*).

Tractor sprockets must frequently be hardened on the inside faces of the teeth. A radiograph is shown which propels the flames and quench along the length of the tooth. When the function of the sprocket necessitates, the roots of the teeth as well as the faces may be surface hardened. A separate water quench, or quench ring, trails the flames. Manual flame-hardening allows concentration of heat at areas requiring maximum depth of hardness. Progressive spinning is employed for fine threads, using a water cooled non-quenching tip. Double quench follows flames. Larger screw threads require the spiral progressive procedure with the flames directed at the thread root. On larger worm threads gear-hardening tips, mounted in a yoke, heat and quench both faces of the threads simultaneously.

Miscellaneous Shapes and Practices, No. 17. (*June 20, 1942, Vol. 86, No. 10, p. 178, 8 figs.*).

The flexibility of the flame-hardening process permits surface treatment of many shapes and sizes frequently encountered which are not subject to standard classifications and procedures. (1) Small internal hemispheres. (2) External hemispheres. (3) Gears and clutch parts. Distortion of thin sections can be minimized by applying the flame to each side rather than to the edge which is to be hardened. (4) A combination of special side tips and different lengths of flat tips will handle many different parts with uniform flange contour.

Set-ups on Unusual Parts, No. 18. (*June 27, 1942, Vol. 86, No. 11, p. 217, 8 figs.*).

Uneven depth of hardness can often be prevented by making slight changes

in the equipment or methods that are employed. Handling curved surfaces. Edges must be protected. Carburizing a roller track.

COOLANT, LUBRICANT.

Extreme Pressure Lubricants. (*Machinery, June 4, 1942, Vol. 60, No. 1547, p. 524*).

With the increase in speed and power output, the ordinary oils available were not capable of carrying the loads, so extreme-pressure (E.P.) lubricants came into existence. Theories advanced relating to load-carrying capacities of lubricants. Industrial uses of E.P. lubricants. The field of E.P. lubricants available for all purposes includes the following classes :—(1) Mineral oil + lead soap + active sulphur compound. (2) Mineral oil + lead soap (with natural sulphur compounds in the base oil). (3) Mineral oil + lead soap + inactive sulphur compound + chlorine compound. (4) Mineral oil + active sulphur compound + chlorine compound. (5) Mineral oil + inactive sulphur compound + chlorine compound. (6) Mineral oil + active sulphur compound. (7) Mineral oil + inactive sulphur compound. (8) Mineral oil + chlorine compound. (9) Mineral oil + phosphorus compound. (10) Mineral oil + chlorine compound + sulphur compound + phosphorus compound. Almost all of these types contain, in addition, a certain amount of saponifiable oil. Precautions to observe in the use of E.P. lubricants. Specification for a universal gear lubricant.

The Performance of Emery Wheels as Affected by Coolants and Lubricants, (*H. Opitz and W. Vits, Z.V.D.I., April 4, 1942, Vol. 86, Nos. 13/14, p. 198*).

The great importance of the nature of the cutting fluids in all turning and planing processes is by now fully recognised. In the case of grinding, however, coolants as distinct from lubricants are still frequently employed. Such coolants as soda water lead to rapid wear of the wheel and the latter requires frequent cleaning in order to remove disintegrated grains adhering to the surface. Under these conditions only 70 per cent of the total approach of the wheel is effective in removing material from the object undergoing grinding, the remaining 30 per cent being taken up by wear of the wheel. In the presence of a suitable lubricant, however, the wear of the wheel only accounts for 5 per cent of the total approach. The great drawback of lubricants is their small thermal conductivity and their tendency to become atomised.

The application of oils is thus restricted to cases when the material does not undergo an appreciable rise in temperature during the process. For grinding screw threads, the oil has proved very beneficial.

(*Communicated by the D.S.I.R., Ministry of Aircraft Production*).

FOUNDRY, MOULDING, PATTERNS.

Foundry Production Problems with Special Reference to High Duty Alloy Cast Iron, by A. E. McRae Smith . (*Foundry Trade Journal, April 9, and 16, 1942, Vol. 66, p. 225 and 241*).

Reference is made to the use of special-process irons and nickel-molydbenum irons of acicular structure, to meet high-duty specifications. The paper comprises a detailed practical discussion of foundry problems associated with production of high-strength irons, means for their solution, and methods suitable for production of particular types of casting.

(*Supplied by the Nickel Bulletin*).

GEARING.

Metallurgical Aspects of Gear Failure, by I. Stewart. (*Mechanical World June 5, 1942, Vol. CXI, No. 2892, p. 509, 7 figs.*).

Types of failure. Fractures. Pitting. Wear. Homogeneity of crystal structure.

JIGS AND FIXTURES.

Special Chucks for Lathe Works, by John G. Jergens. (*The Machinist, June 27, 1942, Vol. 86, No. 11, p. 220, 14 figs.*).

The type of chuck used on a lathe is determined by the design of the work-piece and the volume of production contemplated. The examples shown in the diagrams provide rapid, positive chucking for a wide variety of applications.

MACHINING, MACHINE TOOLS.

Cutting-off and Slitting Operations with Thin Abrasive Wheels. (*Machinery, June, 25, 1942, Vol. 60, No. 1550, p. 607*).

Production cutting-off operations are divided into three classes, viz., dry, wet and submerged. Dry practice involves the use of portable, bench, and floor stand machines, employing chiefly bakelite or rubber-bonded cutting wheels operating at speeds of 7,500 to 16,000 surface feet per minute. With this method of cutting, solid stock of 2 inches diameter or larger should preferably be rotated during the operation. Wet cutting operations are more suitably applied to thick stock. Wheel speeds are usually slower for wet cutting, rarely exceeding 10,000 surface feet per minute. Rubber-bonded cutting wheels predominate in this field of application in which wheel life is improved by as much as 50 per cent over dry cutting. Submerged cutting is particularly suited for cutting heat-sensitive alloys, certain non-ferrous metals and other materials, including glass ; also thin tube stock, where discoloration, distortion and burrs are objectionable. Numerous tool room operations require very thin abrasive wheels, usually of shellac, bakelite or rubber bond for work on metal saws, fine milling cutters, broaches, chasers, reamers, taps and small drills. Miscellaneous slitting and grooving. The power required for driving stand cutting-off machines.

Wheel diameter ins.	Motor H.P.
5 — 8	$\frac{3}{4}$ — $1\frac{1}{4}$
8 — 10	$1\frac{1}{2}$, 2, 3
12 — 14	2, 5, $7\frac{1}{2}$
16 — 20	5 — 15

CHIPLESS FORMING.

Double-action Tool for Use in a Single-action Press, by A. W. Mackrell. (*Machinery, June 11, 1942, Vol. 60, No. 1548, p. 550, 2 figs*).

The oval shell which had to be made to the limits shown. Section through the double-action tool employed.

Rubber Die Practice. (*Aircraft Production, July, 1942, Vol. IV, No. 45, p. 469, 14 figs.*).

Rubber and pressure specifications for flanging, forming and blanking operations : die details : M.A.P. Standardised hydraulic press design.

MANUFACTURING METHODS.

Handley Page Halifax, by Wilfred E. Goff. (*Aircraft Production, July, 1942, Vol. IV, No. 45, p. 452, 40 figs.*).

Part II. Building the nose, rear and tail sections of the fuselage. The tail unit. Engines and mountings. Final assembly.

Manufacturing the Rolls-Royce Merlin XX, by J. A. Oates. (*Aircraft Production, July, 1942, Vol. IV., No. 45, p. 433, 31 figs.*).

Part I. Design and production details: machining the crankshaft and camshaft. The cylinder liners and connecting rod.

MATERIALS, MATERIAL TESTING.

Common High Brass, by R. A. Wilkins and E. S. Bunn. (*Production Engineering, March, 1942, Vol. 13, No. 3, p. 166, B.N.F. Serial 24,766*)

Eleven charts giving the mechanical properties of common high brass strip (66.3 × Cu, 0.03 × Fe, 0.02 × Pb, remainder Zn) in five ready-to-finish grain sizes after annealing and work hardening, and mechanical properties of cold worked and annealed rod.

(*Supplied by the British Non-Ferrons Metals Research Association.*)

The Cold Pressing Properties of Dural Type Alloy Sheets with Special Reference to the Production of Large Pressings for Aircraft, by J. C. Arrowsmith and others. (*J. Inst. Metals, Vol. 68, No. 4, April, 1942, p. 109*).

An account is given of the difficulties experienced in the cold pressing of Duralumin type alloy sheet. The distortion which results from the heat treatment of the material is described, together with the methods for limiting its extent and overcoming its effect. Low ductility and a high degree of "spring-back" make the Duralumin-type alloys less amenable to cold pressing than is mild steel, and methods necessary for the production of the more difficult pressings are discussed.

Attention is drawn to the fact that maximum ductility is not obtained immediately after the water-quenching operation and a series of tests is described which shows that the ductility rises to a maximum after an interval of time which is dependent upon the temperature of storage, and then falls continuously as age-hardening proceeds. This interval of time is of the order of ten minutes at room temperature and two hours at the normal temperature of refrigerated storage (-6° to -10°C.). The effect can be used to advantage in the production of the most difficult pressings.

Evidence is given which shows that a fairly reliable indication of the deep-drawing properties of Duralumin-type alloys is to be found in the microstructure and the value for percentage elongation obtained in the tensile test carried out on freshly solution-heat-treated material.

Mention is made of the success which has attended a deliberate attempt to produce material possessing the type of microstructure which had been found to be associated with good deep-drawing properties.

(*Communicated by the D.S.I.R. Ministry of Aircraft Production.*)

Non-Destructive Testing of Metals and Alloys, by J. W. Donaldson. (*Met. treatment, Spring, 1942, Vol. 8, No. 29, p. 2*).

A survey of all the methods of non-destructive testing—acoustic, optical magnetic and electrical, radiographic, etc. thirteen references to literature.

(*Supplied by the British Non-Ferous Metals Research Association.*)

The Damping Capacity of Engineering Materials, by W. H. Hatfield, G. Stanfield and L. Rotherham. (*Engineering, June 12 and 19, 1942, Vol. 153, Nos. 3987 and 3988, p. 478, 498, 7 figs.*).

It is to be recognised that in most mechanisms where vibrations occur, the damping introduced due to the properties of the materials employed is in general only one factor contributing to damping. The features contributing to damping vary considerably in the different cases. Thus it will be recognised that a welded frame may lack the frictional damping of a similar structure made up by riviting. Forms of expression of damping properties. Damping capacity. The earliest measurements were made on a Cambridge Instrument Company's torsional damping recorder. Nine tables give (1) Damping properties of normalised carbon steels. (2) Damping of alloy steels. (3) Damping capacity of corrosion and heat-resisting steels. (4) Damping of cast irons. (5) Properties of sintered carbide alloys. (6) Damping of nickel, cobalt, etc. (7) Damping capacity of light alloys. (8) Damping of copper alloys. (9) Damping of mild steel and cast iron.

MEASURING METHODS.

Inspection of Bearing Surfaces, by W. N. Twelvetrees. (*Aircraft Engineering, June, 1942, Vol. XIV, No. 160, p. 173, 8 figs.*).

The desired function of any bearing is wear resistance, and in the past materials have been selected possessing certain properties which achieve this end in varying degrees. Generally these were : (1) Good heat conductivity. (2) A metallic structure giving a combination of a soft matrix with hard bearing points. (3) Self-lubricating properties. (4) Freedom from damage when running in contact with foreign matter.

Part I—White Metal, phosphor-bronze and iron. Part II—Steel. Part III—Lead bronze. Part IV—Lead. Part V—Later developments with white metal and bronzes.

PLASTIC MATERIAL

Gears in Plastic Materials, by D. Warburton Brown. (*Mechanical World June 26, 1942, Vol. CXI, No. 2895, p. 577, 7 figs.*).

Early experiments proved that not only had the laminated plastic gears, better wearing properties than ones made from raw hide, but also that they could be stored for long periods without any dimensional changes taking place. The quiet-running properties of laminated plastic gears. Comparison of noise emission from steel and laminated phenolic gear. Plastic materials of the laminated type are unaffected by weak acids, alkalis, petrol, steam, oil or water. Shrouded pinion. Fabric gear with steel driving centre. Gears made from plastic materials may be cut on any machine normally used for machining steel gears. Fabric bevel-gears. Grinding wheel suitable for laminated materials.

Bearings of Plastic Materials, by D. Warburton Brown. (*Mechanical World, June 19, 1942, Vol. CXI, No. 2894, p. 555, 8 figs.*).

To-day this material is, in many instances, replacing the usual bearing materials, e.g., bronzes, white metal and hard woods. Several types of material are available, depending upon the duties of the bearing in question. The fabric, for example, is either coarse or fine and it is used in straight strips stratified, rolled up, or in some cases scrap pieces of material are pressed into moulds. It is also possible to combine the various systems enumerated above. Notes on the various systems are given.

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The type of chuck used on a lathe is determined by the design of the work-piece and the volume of production contemplated. The examples shown in the diagrams provide rapid, positive chucking for a wide variety of applications.

MACHINING, MACHINE TOOLS.

Cutting-off and Slitting Operations with Thin Abrasive Wheels. (*Machinery, June, 25, 1942, Vol. 60, No. 1550, p. 607*).

Production cutting-off operations are divided into three classes, viz., dry, wet and submerged. Dry practice involves the use of portable, bench, and floor stand machines, employing chiefly bakelite or rubber-bonded cutting wheels operating at speeds of 7,500 to 16,000 surface feet per minute. With this method of cutting, solid stock of 2 inches diameter or larger should preferably be rotated during the operation. Wet cutting operations are more suitably applied to thick stock. Wheel speeds are usually slower for wet cutting, rarely exceeding 10,000 surface feet per minute. Rubber-bonded cutting wheels predominate in this field of application in which wheel life is improved by as much as 50 per cent over dry cutting. Submerged cutting is particularly suited for cutting heat-sensitive alloys, certain non-ferrous metals and other materials, including glass ; also thin tube stock, where discoloration, distortion and burrs are objectionable. Numerous tool room operations require very thin abrasive wheels, usually of shellac, bakelite or rubber bond for work on metal saws, fine milling cutters, broaches, chasers, reamers, taps and small drills. Miscellaneous slitting and grooving. The power required for driving stand cutting-off machines.

Wheel diameter ins.	Motor H.P.
5 — 8	$\frac{3}{4}$ — $1\frac{1}{4}$
8 — 10	$1\frac{1}{2}$, 2, 3
12 — 14	2, 5, $7\frac{1}{2}$
16 — 20	5 — 15

CHIPLESS FORMING.

Double-action Tool for Use in a Single-action Press, by A. W. Mackrell. (*Machinery, June 11, 1942, Vol. 60, No. 1548, p. 550, 2 figs*).

The oval shell which had to be made to the limits shown. Section through the double-action tool employed.

Rubber Die Practice. (*Aircraft Production, July, 1942, Vol. IV, No. 45, p. 469, 14 figs.*).

Rubber and pressure specifications for flanging, forming and blanking operations : die details : M.A.P. Standardised hydraulic press design.

MANUFACTURING METHODS.

Handley Page Halifax, by Wilfred E. Goff. (*Aircraft Production, July, 1942, Vol. IV, No. 45, p. 452, 40 figs.*).

Part II. Building the nose, rear and tail sections of the fuselage. The tail unit. Engines and mountings. Final assembly.

Manufacturing the Rolls-Royce Merlin XX, by J. A. Oates. (*Aircraft Production, July, 1942, Vol. IV., No. 45, p. 433, 31 figs.*).

Part I. Design and production details: machining the crankshaft and camshaft. The cylinder liners and connecting rod.

MATERIALS, MATERIAL TESTING.

Common High Brass, by R. A. Wilkins and E. S. Bunn. (*Production Engineering, March, 1942, Vol. 13, No. 3, p. 166, B.N.F. Serial 24,766*)

Eleven charts giving the mechanical properties of common high brass strip (66.3 × Cu, 0.03 × Fe, 0.02 × Pb, remainder Zn) in five ready-to-finish grain sizes after annealing and work hardening, and mechanical properties of cold worked and annealed rod.

(*Supplied by the British Non-Ferrons Metals Research Association.*)

The Cold Pressing Properties of Dural Type Alloy Sheets with Special Reference to the Production of Large Pressings for Aircraft, by J. C. Arrowsmith and others. (*J. Inst. Metals, Vol. 68, No. 4, April, 1942, p. 109*).

An account is given of the difficulties experienced in the cold pressing of Duralumin type alloy sheet. The distortion which results from the heat treatment of the material is described, together with the methods for limiting its extent and overcoming its effect. Low ductility and a high degree of "spring-back" make the Duralumin-type alloys less amenable to cold pressing than is mild steel, and methods necessary for the production of the more difficult pressings are discussed.

Attention is drawn to the fact that maximum ductility is not obtained immediately after the water-quenching operation and a series of tests is described which shows that the ductility rises to a maximum after an interval of time which is dependent upon the temperature of storage, and then falls continuously as age-hardening proceeds. This interval of time is of the order of ten minutes at room temperature and two hours at the normal temperature of refrigerated storage (-6° to -10°C.). The effect can be used to advantage in the production of the most difficult pressings.

Evidence is given which shows that a fairly reliable indication of the deep-drawing properties of Duralumin-type alloys is to be found in the microstructure and the value for percentage elongation obtained in the tensile test carried out on freshly solution-heat-treated material.

Mention is made of the success which has attended a deliberate attempt to produce material possessing the type of microstructure which had been found to be associated with good deep-drawing properties.

(*Communicated by the D.S.I.R. Ministry of Aircraft Production.*)

Non-Destructive Testing of Metals and Alloys, by J. W. Donaldson. (*Met. treatment, Spring, 1942, Vol. 8, No. 29, p. 2*).

A survey of all the methods of non-destructive testing—acoustic, optical magnetic and electrical, radiographic, etc. thirteen references to literature.

(*Supplied by the British Non-Ferous Metals Research Association.*)

The Damping Capacity of Engineering Materials, by W. H. Hatfield, G. Stanfield and L. Rotherham. (*Engineering, June 12 and 19, 1942, Vol. 153, Nos. 3987 and 3988, p. 478, 498, 7 figs.*).

It is to be recognised that in most mechanisms where vibrations occur, the damping introduced due to the properties of the materials employed is in general only one factor contributing to damping. The features contributing to damping vary considerably in the different cases. Thus it will be recognised that a welded frame may lack the frictional damping of a similar structure made up by riviting. Forms of expression of damping properties. Damping capacity. The earliest measurements were made on a Cambridge Instrument Company's torsional damping recorder. Nine tables give (1) Damping properties of normalised carbon steels. (2) Damping of alloy steels. (3) Damping capacity of corrosion and heat-resisting steels. (4) Damping of cast irons. (5) Properties of sintered carbide alloys. (6) Damping of nickel, cobalt, etc. (7) Damping capacity of light alloys. (8) Damping of copper alloys. (9) Damping of mild steel and cast iron.

MEASURING METHODS.

Inspection of Bearing Surfaces, by W. N. Twelvetrees. (*Aircraft Engineering, June, 1942, Vol. XIV, No. 160, p. 173, 8 figs.*).

The desired function of any bearing is wear resistance, and in the past materials have been selected possessing certain properties which achieve this end in varying degrees. Generally these were : (1) Good heat conductivity. (2) A metallic structure giving a combination of a soft matrix with hard bearing points. (3) Self-lubricating properties. (4) Freedom from damage when running in contact with foreign matter.

Part I—White Metal, phosphor-bronze and iron. Part II—Steel. Part III—Lead bronze. Part IV—Lead. Part V—Later developments with white metal and bronzes.

PLASTIC MATERIAL

Gears in Plastic Materials, by D. Warburton Brown (*Mechanical World June 26, 1942, Vol. CXI, No. 2895, p. 577, 7 figs.*).

Early experiments proved that not only had the laminated plastic gears, better wearing properties than ones made from raw hide, but also that they could be stored for long periods without any dimensional changes taking place. The quiet-running properties of laminated plastic gears. Comparison of noise emission from steel and laminated phenolic gear. Plastic materials of the laminated type are unaffected by weak acids, alkalis, petrol, steam, oil or water. Shrouded pinion. Fabric gear with steel driving centre. Gears made from plastic materials may be cut on any machine normally used for machining steel gears. Fabric bevel-gears. Grinding wheel suitable for laminated materials.

Bearings of Plastic Materials, by D. Warburton Brown. (*Mechanical World, June 19, 1942, Vol. CXI, No. 2894, p. 555, 8 figs.*).

To-day this material is, in many instances, replacing the usual bearing materials, e.g., bronzes, white metal and hard woods. Several types of material are available, depending upon the duties of the bearing in question. The fabric, for example, is either coarse or fine and it is used in straight strips stratified, rolled up, or in some cases scrap pieces of material are pressed into moulds. It is also possible to combine the various systems enumerated above. Notes on the various systems are given.

PSYCHOLOGICAL INVESTIGATION.

Tests for Personnel Selection, by Guy B. Arthur, Jr. (*The Machinist, June 6, 1942, Vol. 86, No. 8, p. 101, 9 figs.*).

Does an applicant fit the job? Don't wait until you have put him on the payroll to find out if he has the right abilities. Tests which include personality, mental, and mechanical abilities: The personality test can be graded on four difference bases, namely, sociability, stability, confidence and total personality. The mental test is composed of seven parts; namely, perception, number facility, vocabulary, memory, visualizing ability, induction and reasoning. The O'Rourke mechanical aptitude test is the only purchased test used. Some test charts are shown.

SMALL TOOLS.

Carbide-Tipped Face Mills—I & II, by F. W. Lucht. (*The Machinist, Reference Book Sheet, May 30, 1942, Vol. 86, No. 7, p. 81*).

Nomogramme on speeds and feeds for face milling. Precautions are given when using cemented carbide-tipped cutters. The various materials and the suggested range of cutter peripheral cutting speeds are recommended starting speeds in ft. per min.

Carbide-tipped Face Mills—III & IV, by F. W. Lucht. (*The Machinist, Reference Book Sheet, June 13, 1942, Vol. 86, No. 9, p. 131, 3 figs.*).

Face mills—general purpose work. Face mills—close limit work. Mounting the cutter on the spindle nose. Causes and elimination of chatter. A single stream of coolant sometimes leads to trouble. Semi-circular nozzles keep face mill teeth cool.

Face Mill Mountings—I & II, by F. W. Lucht. (*The Machinist, Reference Book Sheet, June 20, 1942, Vol. 86, No. 10, p. 181, 4 figs.*).

Face mill bolted directly to spindle nose—(1) Centred by outer diameter of spindle. (2) Centred by plug in spindle. Face Mill centred by arbor. Face mill adapted to taper hole in spindle.

Tipped Tools in a Hurry, by Frank W. Curtis. (*The Machinist, June 27, 1942, Vol. 86, No. 11, p. 204, 3 figs.*).

To get carbide-tipped tools quickly, the best procedure is to make your own. Tungsten and tantalum carbide blanks can be obtained readily, and the making of carbide-tipped tools is not at all difficult. Bench-type fixture arranged to hold all sizes and shapes of tool shanks for rapid brazing of carbide tips in place. Each carbide-tipped tool is sketched on a standard data sheet. These tools are rough ground with vitrified wheels, then finish ground in another machine equipped with diamond wheels. Usually the reconditioning of tools can be handled entirely with diamond wheels. By standardizing tips and shanks, it is possible to maintain a stock which permits making up needed tools quickly.

SURFACE TREATMENT.

Building Up of Worn Parts, by W. J. Cumming. (*S.A.E. Journal, April 1942, Vol. 50, No. 4, p. 139*).

Technique of building up automobile parts by spraying and hard surfacing.

(*Supplied by the British Non-Ferrous Metals Research Association*).

The Chrome-Hardening of Cylinder Bores, by H. van der Horst. (*Met. Finishing, February, 1942, Vol. 40, No. 2, p. 69*).

A discussion of the reduction of cast iron cylinder wear by electrodeposited Cr. The deposit must be porous, not dense and highly polished.

(*Supplied by the British Non-Ferrous Metals Research Association*).

The Formation and Evaluation of Zinc Coatings. (*Sheet Metal Industries, July, 1942, Vol. 16, No. 183, p. 953, 7 figs.*).

Methods of forming zinc coatings on iron and steel are discussed and the relative protective values and mechanical properties of these coatings are compared.

Rust-Proofing of Ferrous Metals in Light Engineering Practice, by H. Silman. (*Sheet Metal Industries, July, 1942, Vol. 16, No. 183, p. 997, 5 figs.*).

Review of modern metal finishing processes. Electrodeposited and immersion coatings, conversion of the surface of the metal to one of its more resistant compounds, metal spraying, cementation, cladding, application of an organic coating, and vitreous enamelling. The triple purposes of rust-proofing are: (1) the improvement of corrosion and tarnish resistance, (2) the development of wearing properties or surface characteristics, and (3) the enhancement of appearance; these points are covered in detail.

WELDING, BRAZING, SOLDERING.

Flash Butt Welding of Chrome Molybdenum Steel, by W. S. Evans and V. Netchvolodoff. (*J. Aeron, Sci. Vol. 9, No. 6, April, 1942, p. 207*).

Flash butt welding of steel has been an established industrial process for many years. The automobile industry, in particular, has used this process to take advantage of the low cost, high rate of production and excellent physical properties of the weld.

Application of this process to chrome-molybdenum steels has been very limited, especially in the aircraft industry. Limiting factors for aircraft application have been a lack of production volume, necessary equipment and experience. A natural tendency on the part of aircraft designers has been to exercise caution in the use of processes deviating from long established practices In recent years, with the advent of large contracts, it has become advisable to investigate the possibilities of this process in structural design.

This article will give a brief outline of the many variables involved in the process as well as part and die design. Only in recent years has any effort been made to determine the individual effect of the various factors involved with respect to aircraft steels. It should be remembered that this process as applied to chrome-molybdenum steel is in the development stage and many of the procedures used at the present time may be discarded as a result of further research and additional experience.

(*Communicated by the D.S.I.R. Ministry of Aircraft Production*).

Application of Welding in the Design of Machine Tools, by F. Koenigsberger. (*Welding, June, 1942, Vol. 10, No. 5, p. 107, 11 figs.*).

Lathe bed of fabricated design (Samual Taylor & Sons, Ltd.). Planing machine (W. Sellers & Co., Philadelphia, U.S.A.). Fabricated upright of planing machine. Fabricated upright of an openside planer. Special centreless grinder (Cincinnati). Special hydromatic milling machine (Cincinnati). Vertical broaching machine. Production milling machine (Cooke

& Ferguson, Ltd.). Diagrammatic section of a surface grinder with vertical spindle (Discus).

How Economy in Welding Electrode Consumption can be Effected. (*Machinery, June 4, 1942, Vol. 60, No. 1547, p. 515, 6 figs.*).

The Lincoln Electric Co., one of the largest makers of welding electrodes, has made a study of the factors affecting their consumption and of the costs of welded joints such as are made in the production of ships, tanks, aircraft and many other war essentials. Sixteen types of welded joints. Sketch showing how the fit of joints affects their cost. Graph showing how the increased diameter of welding rod tends to reduce the cost per lb. of metal deposited by welding. Table I—Effect of changing electrode size. Plan and sectional view of welds made with a shielded arc under various conditions. Fillet welds made with shielded arc electrodes under various conditions. Table II—Resulting weld characteristics.

The Inspection of Welded Steel Joints in Relation to their Static Mechanical Strength, by J. Dearden. (*Quarterly Transactions, Inst. of Welding, April, 1942, Vol. 5, No. 2, p. 47, 8 figs.*).

Butt and fillet-welded joints varying intentionally in quality were prepared, examined by *X*-rays, and tested to destruction in tension. The fractures were then inspected and the visibility defects correlated with the radiograph and breaking loads.

WELFARE, SAFETY, ACCIDENTS.

Music While You Work, by L. E. Broome. (*Industrial Welfare, May-June, 1942, Vol. XXIV, No. 282, p. 67*).

Effect on output. When to broadcast. Rhythm and work. Vocals, Radio and record programmes. Buying the records. Who should choose? The week's programme. Typical wartime installation. A matter of taste.

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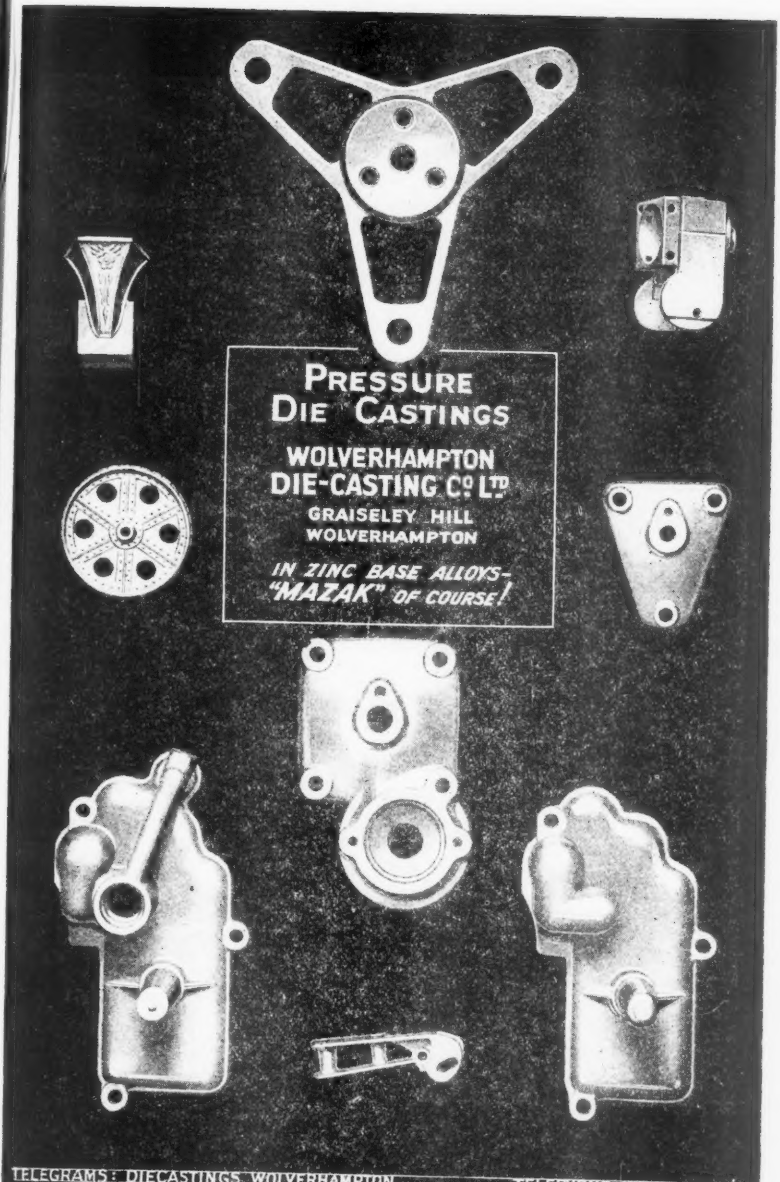
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